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The Impact of Selected Group Processes on the Coordination and Motivation of Army Teams

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The Army is developing a highly mobile, electronically sophisticated command and control vehicle (C2V) to meet the command and control requirements of the modern battlefield. The introduction of the C2V will have a profound impact on how command and control is performed. Increased mobility and access to "real-time or near real-time" critical battle information will significantly challenge the organizational and decision-making skills of the commander and the staff.

In this report, a broad array of group phenomena, which may be altered or controlled in such a way as to promote the successful performance of the C2V crew, were reviewed. There were two objectives in conducting this review. First, we identified from the small group literature, a number of variables that may impact C2V crews in executing the type of tasks required to command and control battlefield forces in a highly automated, digitized, and potentially information-rich environment. These variables dealt with both the coordination and motivation of small groups. Then, when warranted by the literature, suggestions for enhancing C2V crew performance were made, or, as gaps in the literature were identified, hypotheses were generated for testing the relationship between and among these small group variables and battle command performance.

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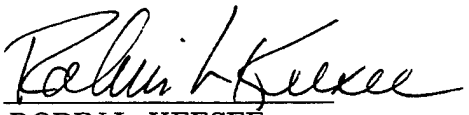
APPROVED: 

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EXECUTIVE SUMMARY

Collective skills have always been the keystone of warfare. Through collective training, soldiers learn to integrate their skills and direct them toward a common objective. The development of technologically complex weapons systems makes collective performance an increasingly important determinant of the outcome of battle. Army contractors are currently refining prototypes of highly mobile command and control vehicles (C2V). The fielding of the C2V will require a series of empirical investigations of collective behavior.

Social psychologists refer to the variables that control collective activities as group processes. Group processes are frequently subdivided into coordination and motivational components. Communication networks, information filtering, environmental and social stressors were some of the coordination literature reviewed. Examinations of motivational processes included cohesion, leadership, diffusion of responsibility, social loafing, free riding, equity, and a modification of equity analyses called dual motivational theory.

The most significant aspect of this report was the identification of research hypotheses, whose testing will have important implications for the performance of Army teams. The systematic pursuit of these lines of research will lead to improvements in the efficiency with which soldiers combine resources and integrate their activities.

THE IMPACT OF SELECTED GROUP PROCESSES ON THE COORDINATION AND MOTIVATION OF ARMY TEAMS

INTRODUCTION

Military histories contain the records of many battles whose outcomes were determined by the collective skills of opposing forces. Acceleration in the pace of warfare and enlargement of the size of the battlefield now make collective skills more critical than ever before. The success of modern military operations often demands the precise synchronization of widespread land, sea, and air forces. This report will examine some important variables that determine how effectively soldiers combine resources and integrate their activities. The objective is to provide the basis for composing military teams to optimize group processes. As new systems such as the command and control vehicle (C2V) are acquired and outfitted with advanced technologies, especially in the area of communications and shared situational awareness, the need to examine how the battle command staffs will exploit these new technologies is critical.

Social psychologists refer to the determinants of collective performance as group processes. The group process literature is voluminous, so no attempt is made to be inclusive. The review is restricted to a subset of group processes that the authors regard as particularly pertinent to the battle command concept. Communication networks, information filtering, leader-subordinate interactions, diffusion of responsibility, and free riding are some of the group process literature that are examined. Following these reviews, areas for future investigation are delineated and hypotheses identified.

One of the group interaction shortcomings that Desert Storm brought to the forefront was the inability of commanders to keep pace with their forces. The Army is currently developing a series of highly mobile C2Vs to rectify this problem (U.S. Army Research Laboratory, 1993). The fielding of the C2V will have a major impact on how command and control is performed. Communication networks, task allocations, and coordination patterns developed with current command posts may not be applicable to a C2V environment. This report will give special attention to the influence of group processes on the performance of C2V crews.

Any assessment of team performance must begin with the individual skills, knowledge, and abilities of group members. For instance, the marksmanship of individual soldiers influences the effectiveness of an infantry platoon. A very simple approach, which we will call the additive model, indicates that team performance is the summation of individual performances.

Group Performance = $Member_1 + Member_2 + \cdots + Member_n$

The results of accident assessments, historical studies, and correlational investigations reveal that the additive model is an incomplete description of group performance. Analyses of aircraft accidents (Prince, Chidester, Bowers, & Cannon-Bowers, 1992) supply some of the most graphic demonstrations of the need to take group process variables into account. In 1978, an entire flight crew became so absorbed with a minor mechanical problem that they allowed the airplane to run out of gas. The U.S. National Transportation Safety Board (NTSB, 1979) concluded that the crash was attributable to a breakdown in teamwork. Responsibilities should have been reallocated among crew members until the malfunction was resolved.

Poor communications among crew members also contributed to the crash of an Air Florida jet into the Potomac River bridge in 1982. After takeoff, the copilot repeatedly but deferentially warned the captain of dangerous ice accumulation. The NTSB (1982) report implied that a more assertive response by the copilot may have averted the disaster. These incidents are representative of accidents within the airline industry. An analysis of multi-crew accidents (Cooper, White, & Lauber, 1979; Foushee, 1984) revealed that communication and coordination failures contributed to most crashes.

Military historians have documented how group processes determined the outcomes of many battles. Sweden's Charles XII was outnumbered four to one by Peter the Great's forces; yet, superior battlefield communications enabled him to decisively defeat the Russians at Narva (Massie, 1980). John Churchill, first Duke of Marlborough, won victory after victory with the same group-disruption tactic (Churchill, 1968). Highly disciplined Redcoats attacked the enemy's strongest point, leading the opposing commander to call for reinforcements. When reinforcements began to move toward the center, Churchill attacked the exposed flank with his cavalry. The suddenness of the cavalry charge required a highly coordinated, simultaneous defense of two positions. Invariably, the enemy was unable to move troops with sufficient rapidity to repel Churchill's attack.

The old Confederate adage to "be there the firstest with the mostest" is another testimony to the importance of fast and coordinated movements. The Civil War would have been mercifully shortened if the Army of the Potomac had moved with the speed and precision of the Army of Northern Virginia. Refined southern gentle folk are much too polite to speculate about why barefoot Confederates could consistently out-march well-soled Northerners.

Empirical regression studies provide the most useful test of the additive model. Most investigations report that the magnitude of the relationship between the mean skill of team members and team performance is small (Bass & Barrett, 1981). For instance, Terborg, Castore, and DeNinno (1976) found that individual skills explained only 3% of the variance in the performance of land survey teams. Jones (1974) discovered that the strength of the relationship between individual skill and group performance depends on the extent of teamwork required. The individual skills of group members accounted for 90% of the variability in the effectiveness of professional baseball teams but only 35% of the variance of basketball teams. The investigations by Terborg et al., Jones, and others do not signify that individual skills are unimportant. A more reasonable interpretation is that individual skills are a necessary but often not sufficient condition for effective team performance. Thus, a different approach is required to supplement the additive model to account for the group processes inherent in the performance of individuals performing as members of a group, crew, or team.

GROUP PROCESS LOSS AND GAIN

Process Loss and Gain

Steiner (1966, 1972) is one of a number of psychologists (e.g., Salas, Dickinson, Converse, & Tannenbaum, 1992), who have stressed that team performance is a joint function of individual skills and group processes. Potential productivity, or the maximum production that a group can achieve, is the central concept of Steiner's model. For a given task, potential productivity depends on member resources and task demands. Member resources are the relevant knowledge, abilities, and tools that the member brings to the task. The relevancy of a resource is task specific. Physical strength is a relevant attribute for digging foxholes but not for decoding messages. Task demands include several components, the most important being the task criterion. For example, soldiers urged to work rapidly will often perform differently than soldiers told that error-free performance is crucial (e.g., Keele, 1986).

Steiner contended that a group's maximum performance can be estimated if member resources are known. The potential productivity of the team is equal to the sum of the individual performances. Notice that except for different labels, the potential productivity equation is identical to the Additive Model.

Potential Productivity = $Member_1 + Member_2 + \cdots + Member_n$

Group performance is often less than the group's potential productivity. Steiner called the discrepancy between potential productivity and actual group performance "process loss." Coordination loss and motivation loss are the two categories of process loss Steiner discussed. Coordination loss occurs when group members do not optimally organize or combine their responses. The inability of some Desert Storm commanders to move as rapidly as the forces they directed is an example of coordination loss. Motivation losses result when members work less hard in a group than they would if they were alone. A member may expend only minimal energy and let other group members "knock themselves out."

$$\textbf{Group Performance} = \sum_{i=1}^{N} \textit{Individual Skills} - \textit{Process Loss} \left\{ \begin{array}{l} \textit{Coordination Loss} \\ \textit{Motivation Loss} \end{array} \right\}$$

The construct of process loss implies that social interaction training can increase group performance. There is some support for this prediction. McRae (1966) found that groups exposed to team skills and individual training outperformed groups given only individual skills training. Formal communications and coordination training within the aviation industry has also been successful (Helmreich & Wilhelm, 1991; Prince, Chidester, Bowers, & Cannon-Bowers, 1992).

Steiner's model assumes that group performance cannot exceed the sum of individual performances. In actuality, group performance often surpasses Steiner's potential productivity equation. Groups may score higher than the potential productivity equation for a variety of reasons. Group members may catch one another's mistakes or assist teammates with excessive work loads. Team membership may also heighten, rather than reduce, motivation.

Steiner's views have been influential and very helpful in understanding group processes. However, potential group productivity may be a misleading term. The potential productivity equation represents the performance of persons working individually but not necessarily the maximum performance possible for that group. The value of the potential productivity equation is that it provides a comparison condition for determining if group processes have a beneficial or detrimental influence on performance.

For example, the potential productivity equation could be used to compute the total pages typed by five soldiers working alone. If these soldiers worked together as a team, scores

greater than the number of individually typed pages would indicate process gain. Similarly, process loss would be found if team performance were less than the sum of individual performances.

Measuring Process Loss and Gain

Steiner (1972) demonstrated how process loss could be assessed experimentally. The following approach is based on his work but allows for process gain as well as loss. Assume that four soldiers were individually tested on a rope pull. The sum of their maximum exertions was 252 kilograms.

Individual Times = 70 + 56 + 60 + 66 = 252

Next, the same four soldiers pulled the rope as a team. Would the maximum pull of the team be greater or less than the total of their performances as individuals? Research (e.g., Ringelmann, 1913) indicates that soldiers would pull less hard as a team than as individuals. The maximum pull of the four soldiers pulling as a team was 212 kilograms, yielding a process loss of 40 kilograms.

Group Performance = 60 + 48 + 50 + 54 = 212

Group Process = Group Performance - Individual Times

Group Process = 212 - 252 = -40

A second example will solidify your understanding this model. The same four soldiers were given a rest and individually timed on an obstacle course. The sum of their times was 160 minutes.

Group Performance = 42 + 47 + 35 + 36 = 160

Later, the four soldiers simultaneously ran the course as a team. How would running the course together affect their times? The obstacle course and rope pull examples have many similarities, so the logical response is that team times would be slower than individual times. However, many studies (e.g., Davis, 1969) suggest that process gain, instead of process loss, would be observed on the obstacle course. Process gain is computed below, using hypothetical but realistic obstacle course times.

Group Performance = 40 + 42 + 34 + 34 = 150

Group Process = Group Performance - Individual Times

Group Process = 160 - 150 = 10

THE TASK

To address group issues, social psychologists began with very simple questions. Do people work better in the presence of others or when they are alone? Are groups or individuals more productive? How should labor be divided among group members to optimize performance? What is the essence of good communication among teammates?

These superficially reasonable questions stimulated pioneering social investigations but eventually led to similar conceptual quagmires. Some studies (for review, see Davis, 1969) reported that establishing teams improved performance. Other investigators (e.g., Latané, Williams, & Harkins, 1979) formed individuals into groups, let them work together, and found substantial inefficiencies. Task allocation designs that increased productivity in one setting produced inferior performance in another. Efforts to ascertain "the best" way for group members to communicate were equally futile. The same communication pattern that facilitated performance in some groups impaired performance in others (e.g., Shaw, 1954).

Conflicting scientific results and disordinal interactions among critical variables are not necessarily undesirable. Often, discrepant findings create pressure for reconceptualizations, ultimately bringing refinement to the discipline. Conceptualization of a scientific issue is largely a matter of perspective, discovering a view that will take one farther.

Eventually, social psychologists recognized that many of the early questions were too simplistic. What appeared to be excellent questions actually had no answers. No theoretical approach could incorporate the existing findings. Any effort to match the data to theory would necessarily be procrustean.

Steiner and others redrew the central questions of the discipline, stressing that the task must be the critical element in any analysis of group performance. Common sense and conflicting and ambiguous research results confirm that to be correct. Once again, so there can be no confusion, the task is the key component of any assessment of group performance.

Many excellent task taxonomies are in the literature (e.g., Davis, Laughlin & Komorita, 1976; Fleishman & Zaccaro, 1992; Hackman & Morris, 1975; McGrath, 1984; Steiner, 1972).

Some of these taxonomies are more complex than is necessary to meet the needs of this report. Other taxonomies are not particularly pertinent to military situations. Therefore, a three-dimensional categorization scheme was developed using aspects of existing taxonomies. The task dimensions are simple-complex, low interactivity-high interactivity, and solitary-additive.

The simple-complex dimension is the foundation of much human performance literature. This dimension does not achieve interval measurement, but tasks can be ordinally positioned. Algebra is usually more complex than addition and trigonometry is generally more complex than basic algebra. Also, task complexity changes with practice; well-practiced tasks are more simple than novel tasks.

The directional effects of many variables depend on their location on the simple-complex dimension. Numerous studies (e.g., Bond & Titus, 1983; Zajonc, 1980) report that an observer facilitates performance of simple tasks and impairs performance of complex tasks. The response of military teams to stress is also a function of task complexity. A common finding is that stress improves the performance of highly trained persons but interferes with the performance of less experienced teammates.

The low interactivity-high interactivity dimension recognizes that group processes are more critical for some team tasks than for others. Successful teamwork is more important in determining the outcome of football games than relay races. Similarly, soldiers marching in formation are generally less interactive than are howitzers or C2V crews.

It is hypothesized that group processes will have their greatest impact on highly interactive tasks. The proposition that team performance is a product of individual skills and group processes is supported in a study by Jones (1974) in which the performance of basketball players is compared to that of baseball players. Basketball is clearly a more interactive sport than is baseball. This implies that individual skill levels should be a better predictor of the success of baseball than basketball teams. This is exactly what Jones found. Individual skills accounted for 90% of the variance in the performance of baseball teams, compared to 35% of the variability in the success of basketball teams.

The interactivity dimension provides a guide for assessing the optimum balance of individual to collective training. Typically, the higher the task is on the interactivity dimension, the greater proportion of training time should be allocated for collective activities.

The solitary-additive dimension represents the extent that a single member can influence group performance. A purely solitary determined task is one in which the actions of one member guarantees the success or failure of a team. Ten soldiers shooting at the same target is a purely solitary determined task. The group will succeed if one member hits the target. Persons familiar with the group process literature will recognize that the marksmen example is what Steiner (1972) called a disjunctive task. Group performance is equal to the performance of the most successful member in disjunctive tasks.

In conjunctive tasks, the group's productivity is the same as that of the least competent member. A squad preparing to move is a conjunctive task; the squad can only proceed when the slowest soldier is ready. Both disjunctive and conjunctive tasks are positioned at the solitary pole of the solitary-additive dimension.

The work of teammates is equally weighted on additive tasks. Additive tasks are leaderless in that each member has the same or equivalent responsibilities. Five soldiers unloading boxes from a truck are performing an additive task.

No general statements can be made regarding the desirability of solitary versus additive tasks. Ideally, tasks should maximize the influence of the most competent member (a disjunctive task) and minimize the influence of the least competent member (a conjunctive task). Usually, other task demands prevent the realization of this ideal.

Training resources need to be distributed differently for additive and solitary tasks. Equal dispersion of resources is usually best for additive tasks. Training for disjunctive tasks should concentrate on the most capable member. Conversely, a disproportionate amount of resources should be spent training the least competent member for conjunctive tasks.

COORDINATION PROCESSES

Steiner's model (1972) subdivides group processes into coordination and motivation components. A diverse array of coordination and motivation phenomena will be sampled, ranging from communication structures to stress and cohesion to reward efficiency and equity. The basic strategy is to present an overview of the literature, followed by a plan for investigating coordination and motivation processes.

Introducing Communication Networks

Coordination depends on the passage of information among group members. Informational links between group members are often depicted as communication networks. These networks show who communicates with whom.

The importance of communication networks has long been recognized by social psychologists (e.g., Leavitt, 1951). Regrettably, organizations seldom apply the lessons of this research. Many managers, uninformed about the influence of networks, simply link members if one needs information from the other. Communication networks established in such a haphazard manner frequently underlie group inefficiencies. Often, inadequate team performances resulting from improper networks could have been corrected by better planning.

The introduction of the C2V presents an excellent opportunity to systematically apply the findings of communication network studies. This review will show that the choice of networks affects team performance, task allocation, and the ability of the group to respond to change and stress.

Figure 1 illustrates several basic communication networks. These networks can be regarded as groups of individuals or larger entities. For example, Figure 1A could be a group of five persons or five C2V crews. In many small groups, all members can communicate with one another. Complete reciprocity of communication is typical of four persons sitting about a table (see Figure 1B). Unrestricted communication is not characteristic of all small groups. Some small groups and all large groups impose boundaries on information flow. All groups in Figure 1 except Figure 1B, impose some limitation on information transmission.

Much of the research about networks has contrasted decentralized and centralized systems. Figures 1B and 1D are called decentralized networks because all group members have a potentially equal impact on communication flow. Centralized networks, in which messages are routed through a key member, are depicted in Figures 1A and 1C. The communication patterns among C2V crew members more closely approximate Figure 1C than do the other networks shown in Figure 1. A key member is at the information hub and has more influence and opportunity to interact with each of the other members, but adjacent non-key members can communicate.

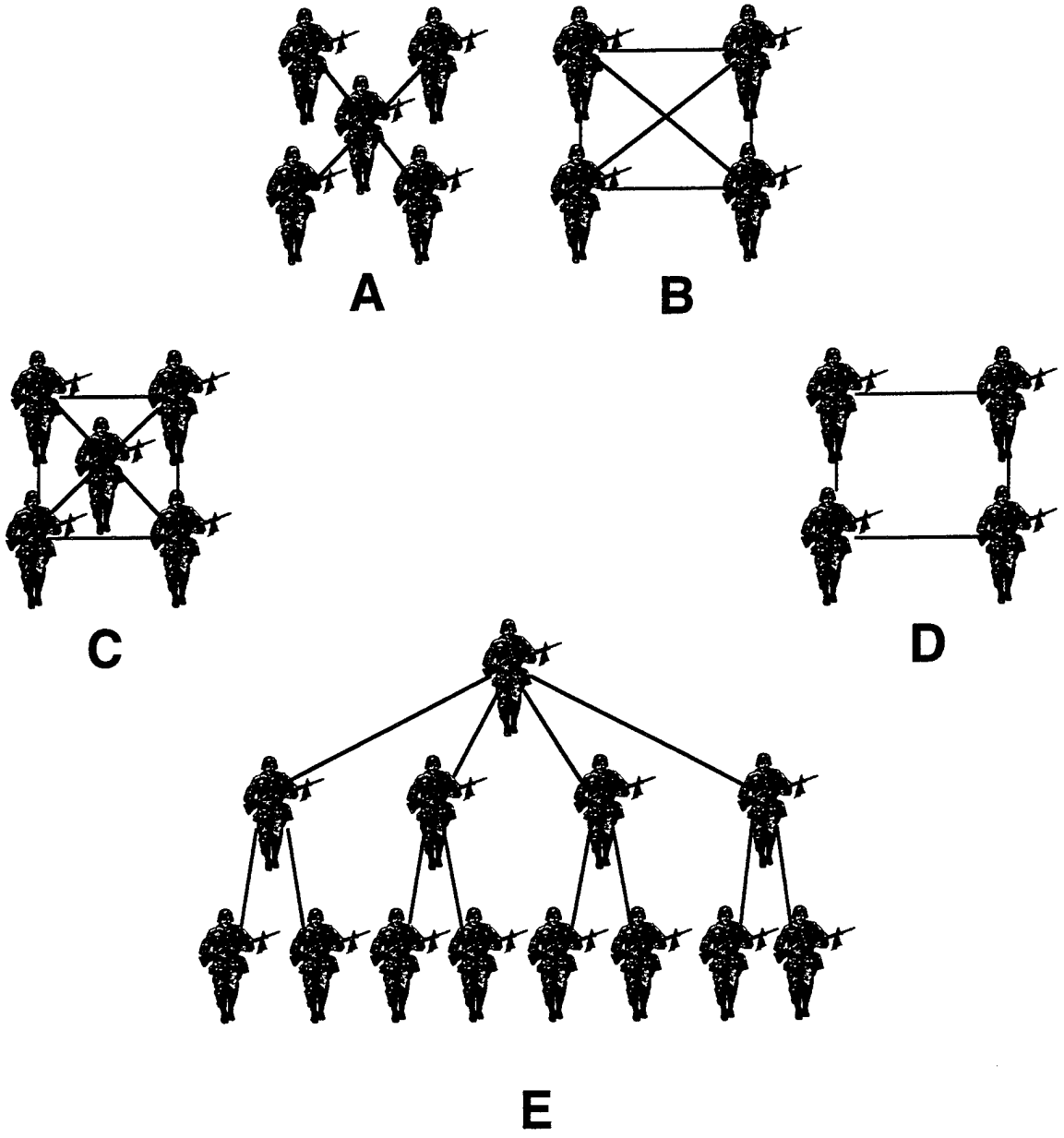


Figure 1. Some basic communication networks.

A number of studies (Hirota, 1953; Shaw, 1954; Shaw & Rothschild, 1956) found that the key person in a centralized network will probably be seen as the most important member. This could be an important asset in military groups in which it is desirable for a certain individual to be regarded as a strong leader. Conversely, centralization can lead non-key members to believe that their contributions to the group are relatively insignificant.

The primary benefit of centralized networks is that they enhance coordination. Concentrating organizational and directional functions in a single member reduces the number of

communications and the complexity of social interactions. Only the key member must have an overall plan for the group to achieve synchrony in a centralized network. In contrast, each member must know what every other member is doing for a decentralized network to function in unison. How important coordination gains are to performance depends on the location of the task on the low interactivity-high interactivity dimension; good coordination is more vital for highly interactive tasks.

Centralized networks also save time by reducing discussion. Anyone who has endured meetings in which everyone felt compelled to comment can appreciate the time savings that centralization can bring. Superior coordination and less time wasted in discussion are the hallmarks of centralization. These two forces usually combine to ensure that centralized groups outperform decentralized groups in simple or highly practiced tasks.

Certain problems are characteristic of centralized networks. Non-key members often are dissatisfied with the group experience. The disdain that many people feel for leaders can be partially attributed to the lack of communication and distance represented by the centralized network. It is interesting that two popular leaders, Roosevelt and Eisenhower, were very successful in creating images of accessibility. Franklin Roosevelt mastered the new medium of radio and gained support by his fireside chats (Freidel, 1990). Eisenhower was frequently photographed talking with GIs (Sixsmith, 1972).

Centralized networks sometimes impair group performance by concentrating too many activities on the key member. Although not yet empirically demonstrated, it is probable that information is particularly likely to bottleneck at the key member during sudden increases in work load. Centralized groups may perform well under moderate work loads but unravel during periods of high activity.

The human engineering assessment of the C2V (U.S. Army Research Laboratory, 1993, p.5) reported that "the S3 experienced a heavy workload." More equitable task allocation and improved hardware and software may eventually correct this problem. Still, it is noteworthy that overextension of the key member is a potential hazard for centralized groups, such as C2V crews.

The main disadvantage of centralized networks is that they have a counterproductive impact on the performance of complex tasks, especially those requiring creative solutions. Most

failures in centralized networks occur because the key member is unable to solve the problem. Decentralized networks are slow but have the advantage of generating many alternate solutions.

The choice of a network will heavily depend on the position of the task on the simple-complex dimension. Centralized networks yield superior performance of simple or repetitive tasks. Decentralized networks are usually best for complex or novel tasks.

Centralized and decentralized networks are usually a part of larger hierarchical networks. Figure 1E shows a 13-unit hierarchical network. The units of this network can symbolize individuals, C2V teams, governmental departments, or even larger entities. All Army groups are components in hierarchical networks.

Hierarchical networks are an integral part of modern society. They are the communication framework that makes large organizations possible. Small hierarchical networks are parts of larger networks, which are subsumed into still larger networks, ad infinitum.

Complex activities, such as flying an airliner, running a company, or conducting a battle plan invariably rely on hierarchical networks. Hierarchical networks link all people together, enabling individuals we seldom or never meet (e.g., the President) to affect our lives. Despite or perhaps because of their omnipresence, few people recognize the powerful influence of these networks on organizations.

Hierarchical networks are similar to centralized networks in that information passes to a key decision maker or organizer. A crucial difference between hierarchical and centralized networks is that the key member in a hierarchical network communicates with a subset of group members. Restricting access protects the key member from work overload. The key member of the hierarchy in Figure 1E can potentially direct all group members but only interacts with three persons.

In addition to insulating the key member from overload, hierarchical networks facilitate the division of labor. Persons of different experiences and abilities can be incorporated at different levels of the hierarchy. Typically, higher ranking members perform more complex tasks than do lower ranking members.

Sometimes control by key persons in a hierarchical network is more theoretical than actual. It is an American tradition for incoming administrations to express surprise that they

have limited ability to change the Federal bureaucracy. Multiple hierarchical networks tend to move on their own despite pressures from key members from the top.

Causality is usually bi-directional in hierarchical networks. Leaders of large hierarchical networks can alter organizations, but organizations also alter leaders. Being the key member of a massive hierarchical network is like tying a boulder to your leg and standing on a steep hill. You may be able to drag the boulder up the hill, but you may also be sent rolling along to the bottom of the hill.

Inflexibility and insensitivity to change are serious shortcomings of hierarchical networks. Historically, only national crises, such as the Great Depression or major wars, significantly alter the course of giant hierarchical networks. This inertia is not an American creation, nor is it new. "Bureaucrat" is a French word and the adjective, "Byzantine," referred to the intricacies of that government's hierarchical networks.

Overgrown hierarchical networks are problems for business as well as government. Plunging International Business Machine (IBM) stock prices can be conveniently blamed on a small group of leaders, but that is not the main cause of the company's decline. IBM decisions had to pass through a multi-layered hierarchical network, developed over the company's history. IBM was unable to respond to the rapidly changing electronic technology market with the speed of smaller competitors. As a result, IBM consistently marketed last year's products this year.

The resistance of hierarchical networks to change provides some seldom noticed benefits. Hierarchical networks give stability and shield group members from sudden chaotic changes. They secure the norms and roles (e.g., Milgram, 1974; Sherif, 1936) that underlie efficient social interaction.

Hierarchical networks can also exhibit a remarkable flexibility in emergencies. The U.S. political system produced Washington, Jefferson, Jackson, Lincoln, Wilson, the Roosevelts, and Truman at critical junctures. Fillmore, Pierce, Hayes, Harrison, Harding, Coolidge are representative of Presidents during less tumultuous times.

Military hierarchical networks can also quickly respond to extreme threat. A case can be made that Pearl Harbor brought the death of the post-World War I military. With the notable exceptions of Marshall and MacArthur, few of the highest ranking military leaders in 1941 held key positions at the end of World War II.

The U.S. political and military systems produce one type of leader in dire situations and a different type of leader during more tranquil interludes. This conclusion is consistent with many scientific leadership investigations. The effectiveness of leadership style depends on group circumstances (e.g., Fiedler, 1967; Suedfeld & Rank, 1976). A successful style of leadership with one group and situation is often ineffective in other circumstances.

High interactivity is a significant feature of almost all tasks conducted within a hierarchical network. The overall task is distributed among group members so that no individual can accomplish it alone. Hierarchical networks force mutual dependence; only by working together can the group achieve its mission.

Tasks performed using hierarchical networks are usually near the middle of the solitary-additive dimension. In several respects, hierarchical groups resemble teams performing solitary tasks. The key member in a hierarchical network has a disproportionate influence on group performance. Hierarchical groups also rank near the solitary pole, because an error by a single member can cause the entire group to fail. A person low in the hierarchy may not convey information that is vital to the group's success. Reportedly, such an oversight contributed to the disaster at Pearl Harbor (Prange, 1991). Operators identified a large blip on the radar 132 miles from Oahu. This finding was relayed to a Lieutenant Tyler, who felt that the information was not sufficiently important to transmit to his superiors.

Hierarchically networked groups also have attributes of teams working on additive tasks. The large number of people composing many hierarchical networks dilutes the ability of the key member to initiate changes. As the hierarchy grows in size, the key member has authority over more people, but the ability to control actions of individual members declines.

Task Allocation

Task allocation and communication network issues are invariably intertwined. The allocation of tasks often governs the establishment of communication links, and the type of network determines if a particular task allocation strategy is viable.

The introduction of the C2V will not alter the functions of a command post, but it will change the way those functions are accomplished. Crew size will be different and new electronics will transform how communications are performed. How tasks can best be allocated among a C2V crew will depend on a vast array of variables. These include the

1) tasks to be performed;
2) extent that tasks can be sequentially done or must be performed in parallel;
3) degree that cognitive interference results from dual task performance;
4) feasibility of cross training of C2V crew members;
5) necessity of overlapping tasks;
6) proportion of time that the C2V is stationary and moving;
7) communications among C2V's;
8) crew size;
9) variants of the C2V;
10) maximum and average time lengths that the crew must remain in the vehicle; and
11) habitability of the C2V.

Efficient task allocation is complicated by the situational changes characteristic of many military groups. A task distribution plan that is effective in one circumstance may fail as conditions change. For example, assume that a personnel officer is the key individual in a five-person network. Experienced personnel officers are very familiar with most of the tasks that they must perform. Simple or well-practiced tasks make few cognitive demands and are best handled by centralized networks, such as Figure 1A. What if something unexpected happens and the personnel officer must confront a novel or complex problem? Research indicates that decentralized networks (e.g., Figures 1B and 1D) are most likely to be successful.

Groups also experience fluctuations in work load that can affect the functionality of the communication network. A centralized network that typically works well can overextend the key member in times of stress. Information can out-race the processing ability of the key member, resulting in coordination disintegration and the group losing control of the situation. This is a potentially serious problem for Army teams that train in relatively relaxed atmospheres but must perform during highly stressful battlefield conditions.

Changing situational demands require that the group smoothly shift communication patterns and reallocate work loads. For many new C2V commanders, the greatest coordination problems will occur in switching communication networks and redistributing tasks among crew members. Lessons learned under the current command post structure may not generalize to new personnel and equipment. Investigations will need to be conducted to determine when and how shifting should occur between networks and tasks.

Information Filtering Systems

The way that groups use information is often based on the traditions of the organization. Historically, military commanders have suffered from a lack of information. Sometimes information was so sparse that extraordinary events happened. Seventy-five thousand Confederate and 82,000 Union troops almost blundered into one another at Gettysburg (Catten, 1974). It is not surprising that the goal of previous military communication systems was to provide the commander with as much information as possible. Information was assumed to assist decision making--the more information, the better.

Modern intelligence systems make it highly improbable that 157,000 soldiers could move unnoticed anywhere in the world. The undetected relocation of divisions of Chinese Communists along the Yalu in 1950 (Hastings, 1987) may be the last event of its kind in military history. The continual development of better communication systems will ensure that the amount of information available to military teams will increase geometrically.

The abundance of information has solved some problems but amplified others. Electronic technologies can potentially supply decision makers with much more information than they can efficiently use. The quantity of information has increased tremendously, but human information processing abilities have not. Many investigations (Kahneman, 1973; Norman & Bobrow, 1975; Wickens, 1989) have demonstrated that performance is impaired when information or task demands overwhelm cognitive capacities. The old assumption that more information results in better decision making is no longer tenable.

Groups attempt to prevent cognitive overload by reducing or filtering the information that is passed to other members. A filtering system refers to a scheme for determining how much and what information will be transmitted. The commander's critical information requirements is an example of a filter set to ensure the passage of certain data. The rules governing effective filtering are immutable. The more restrictive the filter, the greater the process gain. However, the failure of significant information to pass through the filter can produce extreme process loss and calamity.

The best filtering system depends on the group's functions, personnel, and equipment. New equipment, such as the C2V, almost invariably requires alterations of the information filtering system. The eventual installation of more sophisticated communications devices will

augment the need to create different informational filters. Empirical investigations will be needed to determine the optimal filtering strategy for each type of C2V crew.

Environmental Stressors

The ability to maintain efficient coordination under stress is one of the primary determinants of team success. Analyses of cockpit recordings indicate that crashes are often preceded by communication breakdowns. Some of these problems include an inability to completely process information, the sending of partial or incomplete messages, and failure to simultaneously perform vital tasks (Huey & Wickens, 1993). Even in non-emergency situations, groups are still subject to social and environmental stressors that can impair coordination.

The initial test of the tracked variant of the C2V revealed high noise levels, extensive vibration, and uncomfortable temperatures (U.S. Army Research Laboratory, 1993). Design refinements will mitigate, but not completely eliminate environmental stressors in the C2V. Understanding the effects of these and other stressors on cognitive processing, coordination, and performance is an important step in developing effective C2V teams.

Much of the research about the relationships of environmental and social stressors has invoked the construct of arousal. Stressors are assumed to augment arousal, which in turn affects performance. The basic finding of this literature is that moderate levels of arousal usually produce the best performance. Very low levels of arousal and very high levels of arousal are usually associated with poor performance. The relationship of arousal to performance is often depicted as an inverted U (see Figure 2).

The inverted U was initially described by Yerkes and Dodson in 1908 and it is still central to understanding how stress impacts performance. A study by Simonov, Frolov, Evtushenko, and Suiridov (1977) provides a good illustration of the effect of arousal on performance. Simonov et al. had first time parachutists perform a visual detection task as the time for their jump approached. They also obtained physiological indices of stress or arousal. Their results showed that stress continued to increase as the jump time approached. Visual detection performance improved as stress increased from low to moderate levels. However, stress peaked just before their jump, causing a deterioration in performance.

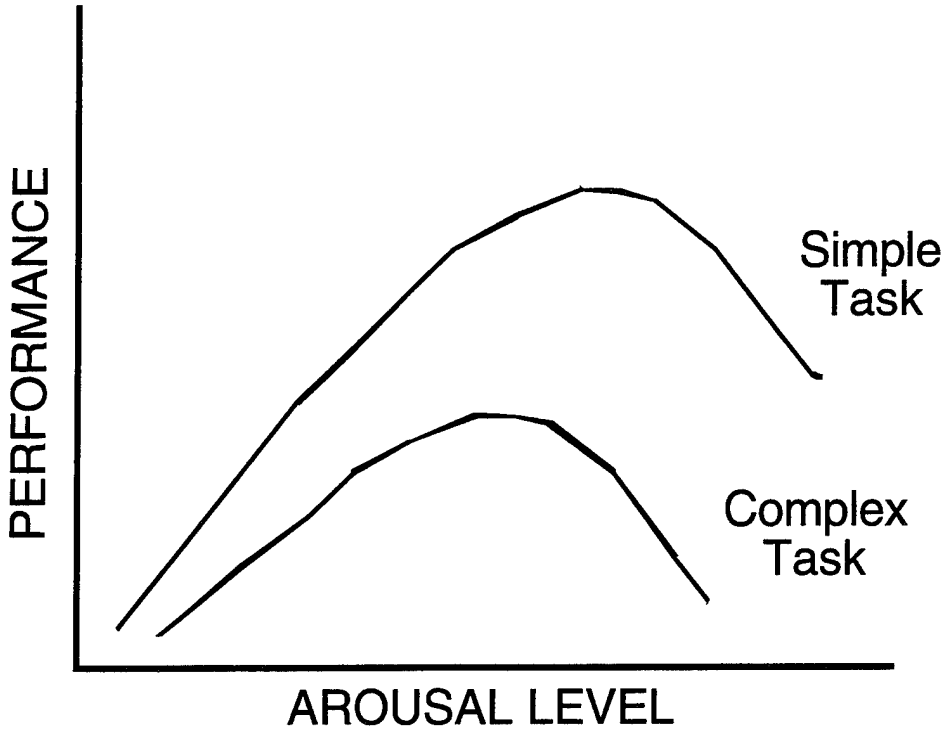


Figure 2. The relationship of arousal to simple and complex task performance.

The curvilinear relationship of arousal to performance reveals that stressors have beneficial as well as detrimental effects on task performance. Optimal performance is unlikely in a quiet, vibration-free, 72° environment. Everyone who has contended that it is difficult to learn in a tomb-like library may relish some confirmation from these findings. For example, in respect to noise, the goal should not be noise eradication but noise management.

The interaction of arousal and task complexity suggests why training to the point of overlearning attenuates the detrimental effects of stress on performance. Practice makes initially complex tasks easier. A study by Martens (1969) demonstrated the conjoint effects of arousal and practice on performance. Martens found that audience-induced arousal impaired the performance of novices in a perceptual motor task. In contrast, highly practiced subjects obtained better scores when tested before an audience than when tested alone.

Different processes appear to be responsible for the upward and downward "limbs" of the inverted U (e.g., Easterbrook, 1959; Kahneman, 1973). An energizing process produces the upward limb. As arousal or stress increases, greater amounts of cognitive resources are directed toward task performance. For instance, vehicle vibrations or the presence of a superior officer

(e.g., Bergum & Lehr, 1962) could increase the cognitive effort of soldiers performing a vigilance task.

The downward limb is the result of a narrowing in the scope of attention. As arousal increases, the soldier attends to fewer aspects of the environment. The directional effects of this reduction in attentional focus depends on the task. Simple tasks usually consist of few informational sources and may be unaffected or even facilitated by a restriction in attention. On the other hand, complex tasks usually require the use of multiple information sources. Narrowing of attention or tunneling may lead the soldier to ignore significant aspects of the task, producing a deterioration in complex task performance.

Hockey (1984, 1986) reviewed the effects of various stressors on generalized arousal, selectivity of attention, speed, accuracy, and working memory. Hockey's findings (see Table 1) reveal that stressors have very specific effects on information processing. High levels of background noise augment generalized arousal and narrow attentional focus. In contrast, sleep loss reduces generalized arousal and broadens the scope of attention. Each stressor has a unique signature. Generalizing the results of investigations using different stressors is often very limited.

One of the most serious effects of stress is on the selectivity of attention. High selectivity appears to have affected decision making at Three Mile Island (Rubinstein & Mason, 1979). High stress caused operators to focus undue attention on a single indicator, which showed that the water level in the reactor was too high. More reliable indicators that revealed that the water level was too low received little or no attention. The operators, having misdiagnosed the situation, decided to stop an emergency water pump, greatly exacerbating the problem.

Commanders and other decision makers have a tendency to restrict attention in stressful conditions. High selectivity or attention tunneling will enhance the subjective importance of certain events at the expense of others. Swedish General Roos at the Battle of Poltava in 1709 unexpectedly had difficulty assaulting two unimportant Russian redoubts (Creasy, 1955; Fuller, 1954). The redoubts posed little threat to the Swedes and should have been bypassed if not quickly overcome. Roos wasted six battalions (one-third of the Swedish infantry) in a time-consuming attack on the redoubts.

Table 1

Effects of Stress Across Different Cognitive Indices

	Performance indicators				
	GA	SEL	S	A	WM
Alcohol	-	+	-	-	-
Anxiety	+	+	O	-	-
Depressant drugs	-	-	-	-	-
Earlier time of day	-	?	-	+	+
Fatigue	-	+	-	-	O
Heat	+	+	O	-	O
Incentive	+	+	+	+	+
Later in day	+	?	+	-	-
Noise	+	+	O	-	-
Sleep loss	-	-	-	-	O
Stimulant drugs	+	+	+	O	-

Note. The table summarizes the most typically reported effects of stress. GA = general alertness/arousal; SEL = selectivity of attention; S = speed of responding; A = accuracy of responding; WM = working memory; + = increase in responding; - = decrease in responding; O = no effect on responding; ? = unknown.

General Roos' fixation with the redoubts is a classic example of tunneling. He responded to the redoubts as if they were a major problem and in doing so, created a major problem. The Swedes made a fundamental error early in the battle from which they never recovered. Why did Roos make this error?

It is easy to conclude that Roos was an incompetent general, but this is only a label and explains nothing. An analysis of Poltava indicates that most Swedish commanders were inadequately briefed about how their missions fit into the overall battle plan. People are particularly vulnerable to attentional tunneling in times of uncertainty. Roos did not have a good resource allocation plan, so he focused on what he knew. Those two redoubts were not neutralized.

In a calm environment, even without a knowledge of the overall strategy, Roos would probably have concluded that these redoubts did not justify a major diversion of forces. It is a reasonable conjecture that stress and the lack of a predetermined plan combined to produce his undoing.

Roos directed battalions, but the problem of effectively managing resources during stressful conditions is inherent at all levels of military organization. The commander of a C2V will exhibit a restricted focus under stress, concentrating on certain activities to the exclusion of others. This is to some extent desirable, because only critical activities should be performed during stressful conditions. The problem is that people under stress are very poor prioritizers. Tunneling enhances the subjective importance of some events and ignores other events equally important. The best remedy for attentional tunneling is a predetermined model of task allocation and priorities.

Stress and the Centralization of Power

One important effect of stress is that it alters the magnitude of influence that subordinates have on decision making. These changes in the rules of group interaction sometimes result from severe time constraints that accompany high stress. In battle, survival may depend on a quick response from the commander. However, stress modifies the leader-subordinate relationship even when group members have ample time to share information before making a decision.

Many historical examples suggest that societal stress often precipitates a concentration of authority. Citizens are frequently willing to relinquish their rights in an emergency, making possible the emergence of a Caesar, Napoleon, or Hitler (e.g., Hertzler, 1940). In the United States, the Constitutional Convention confronted the crises of post-Revolutionary America by creating a stronger central government (Peters, 1987).

The organizational literature (e.g., Hermann, 1963; Holsti, 1971; Milburn, Schuler, & Watman, 1983) finds that large groups respond to stress by concentrating decision making in the upper levels of the hierarchy. Staw, Sandelands, and Dutton (1981) contended that the localization of power is an adaptive response to stress because it places responsibility on those persons most central to the values and goals of the organization. Small group studies also report that stress increases the power of leaders. For instance, Hamblin (1958) showed that groups were more likely to accept a leader's suggestions under stress. Group members also attribute greater responsibility to leaders during periods of stress (Klein, 1976).

Historical interpretations and organizational and small group studies consistently find that stress increases the deference of subordinates to superiors. Power moves away from the many to the few. Why does power concentrate at the top during stressful conditions? One interpretation is that leaders react to stress by curtailing input from subordinates. Subordinates have little influence in stressful circumstances because they are actively thwarted by their leaders. The leader's motivation for isolating himself or herself could be stress reduction. Leaders can gain at least a temporary respite from the fear of failure by insulating themselves from the dissenting views of subordinates.

A second alternative is that subordinates actively avoid becoming involved in decision making during stress. They seek refuge in their subordinate roles, unwilling to share responsibility for potential failures. We will now unravel these suppositions by examining how stress influences the response of leaders to input from subordinates.

The Response of Leaders to Followers in Times of Stress

The centralization-of-authority hypothesis is that leaders become increasingly isolated in stressful conditions and discourage informational input from their subordinates (e.g., Holsti, 1971; Smart & Vertinsky, 1977). Centralization of authority results in an increasingly unidirectional information flow, going from superior to subordinate. An alternate hypothesis is that during stress, leaders and subordinates become very responsive to input from other group members. Subordinates are more willing to follow the guidance of leaders, but leaders are also more likely to search for information and advice from their subordinates. Driskell and Salas (1991) refer to this bi-directional acceptance of input as the increased receptivity hypothesis.

The studies to date reveal that the concentration of decision making in times of stress is not typically the result of autocratic leadership. In fact, leaders usually become more rather than less open to opinions of subordinates as stress rises. The most likely interpretation of the findings is that subordinates under stress try to avoid becoming involved in decision making.

A study by Lanzetta (1955) provides some support for the increased receptivity hypothesis. He found that elevations in stress augmented opinion seeking and group discussion. Torrance (1967) obtained results that are consistent with Lanzetta's findings in a study of the effects of stress on military teams. Subordinates became more deferential to leaders during

stressful conditions. However, stress also caused leaders to become increasingly responsive to the viewpoints of subordinates.

Driskell and Salas (1991) examined the effects of status and stress on the decision making by dyads. Dyads were composed of U.S. Navy personnel of different ranks. Subjects in the high stress condition were told that a small amount of tear gas would be dropped in the room as they worked on a task. Persons in the low stress condition were not given this expectation. As anticipated, subordinates in the high stress condition were more willing to accept the opinions of their superiors than were subordinates in the low stress manipulation. The most interesting finding was that stress also increased the receptivity of the higher ranking person to input from the subordinate. These results provide strong support for the increased receptivity hypothesis.

Groupthink

In stressful conditions, subordinates often "rally round" the leader. This tendency, although often appropriate, has a potential danger. Subordinates in stressful conditions are especially likely to confuse concurrence with the leader's views with loyalty to the leader. The unfortunate leader may incorrectly assume that a group of individuals has independently discovered the wisdom of his or her plan. Janis' analysis (1972, 1983) of "groupthink" describes how stress and conformity pressures can be prescriptions for disaster.

Janis contends that groupthink is a pathology that results when stress, high group cohesion, and leadership style combine to stifle dissension by subordinates. According to Janis, groupthink has contributed to a variety of foreign policy disasters, including the Bay of Pigs invasion, the decision by Argentine generals to initiate the Falkland Islands War, and Lyndon Johnson's belief that American opposition to the Vietnam War was restricted to a few extremists and oddballs.

There are probably many ways to curtail dissent and induce groupthink. Active suppression is one of the more blatant. Robert Kennedy coerced a cabinet member to retract his objections during the discussions that led to the Bay of Pigs invasion. Kennedy's rationale was that the President needed support.

The processes producing groupthink are often more subtle than active suppression. Frequently, subordinates believe that a certain plan is favored by the group. They are impressed that no one else is offering alternatives and they assume that silence reflects advocacy of the plan. How could he or she be right and all of those well-respected people be wrong? It must be a great plan after all. By refraining from dissent, the subordinate reduces uncertainty among group members and retains the good will of the group.

Janis has theorized about the situational determinants that produce groupthink. Groupthink is most likely to occur in a crisis or highly stressful situation. Subordinates, who have a strong need to be accepted by the group, are particularly susceptible. A directive style of leadership also exacerbates groupthink. This is especially the case when the leader makes the favored option apparent early in the decision-making process.

Very high feelings of group cohesiveness, such as those experienced by policy-making groups, are difficult to generate in the laboratory. As a result, there are a limited number of investigations of groupthink. Not unexpectedly, several attempts (e.g., Leana, 1985) to manipulate group cohesion have not yielded results predicted by Janis' theory. Laboratory studies (e.g., Flowers, 1977) have provided more support for the proposition that directive leadership produces poor decision making.

Historical studies have generally confirmed Janis' hypotheses. Tetlock (1985) used a quantitative content analysis to compare policy decisions that Janis had previously characterized as reflecting groupthink with decisions categorized as non-groupthink. As predicted, public statements of leaders involved in groupthink decisions were more simplistic than the statements of leaders involved in non-groupthink decisions. Herek, Janis, and Huth (1987) reported a negative correlation between the number of groupthink symptoms and the quality of decisions. A recent study by McCauley (1989) revealed that the most important elements of groupthink are a directive style of leadership, the homogeneity of group members, and the protection of the group from outside influences.

Findings based on historical analysis must be regarded with caution because examples that do not confirm groupthink could have been overlooked. Despite this admonition, there is little doubt that groupthink does occur and can lead to poor decisions. Janis' theorizing is also consistent with Driskell and Salas' (1991) finding that stress increases the reluctance of subordinates to make decisions. Groupthink can be viewed as one way that subordinates escape their decision-making responsibilities.

Several characteristics of the C2V social environment make groupthink a prominent danger. C2V crew members are homogeneous in that they are Army personnel and most likely share many attitudes and values. There is also a strong incentive to receive the approval of the leader and other group members. All soldiers recognize that promotion depends on an excellent evaluation from superiors and on their being perceived as good team members. Stress may be the activating agent in this chemistry, stifling dissent and leaving the leader with few viable options.

Summaries, Data Gaps, and Hypotheses

The coordination studies reviewed in this report will now be used to generate hypotheses to be tested with Army teams. Coordination effects are often specific to the equipment, personnel, and objectives of the team. Therefore, the research proposals in this section should be tested with actual Army equipment or in high fidelity simulators.

Communication Networks

Communication networks depict the informational links between teammates. Networks provide the framework or structure around which the group integrates its actions. The selection of communication networks affects group performance and is consequently a particularly important topic for military teams. Centralized networks (e.g., Figure 1A and 1C) produce better performance than decentralized networks (e.g., Figure 1B and 1D) if the task is simple. Conversely, decentralized networks are superior to centralized networks for complex tasks. Another problem with centralized networks is that they may be vulnerable to overloading of the key member.

Maintaining a high level of performance usually requires smoothly coordinated transitions between networks and tasks. Group members have traditionally relied on their own experience to determine when to change networks or assist an overloaded teammate. An alternate approach is to empirically assess when and how networks and task switching should occur. No definitive recommendations can be made to direct the actions of the C2V crew. Thus, this will be an important variable to be examined.

Filtering and Processing Information

Electronic information-gathering technologies give U.S. forces a significant advantage over any potential adversary. The abundance of information currently available is in marked contrast

to the data dearth characteristic of previous generations. Like all technologies, computers and satellites have solved some problems and created others. Increases in the quantity of useful data will require

1) More precise communication and coordination. The greater the information soldiers must process, the higher the probability of communication and coordination breakdowns.

2) Better information filtering. Larger amounts of information augment the likelihood that pertinent data will be overlooked.

3) More restrictive filtering of data. A smaller proportion of data will be transmitted via the hierarchical network.

4) Greater insulation of decision makers from being overloaded with information.

5) Increased emphasis on automation.

6) Better information processing skills by all decision makers.

Each item on this list is a processing rather than a data production problem. The ability to process information has not kept pace with the technology to generate information. Producing the information is the easy part; knowing what to do with it is a far more complex problem.

New ways must be found to alleviate this processing bottleneck. Teaching soldiers better information processing skills is a viable but seldom tried means of improving data handling. Filtering, sorting, prioritizing, and interpreting skills must become a part of the training of every noncommissioned and commissioned officer.

The Army must take the forefront in developing an information processing curriculum. The best strategy for accomplishing this objective is to use cognitive psychology as a guide. Basic researchers in cognitive psychology have made substantial progress identifying the determinants of effective information usage. Now is the time for the Army to initiate a research program that translates these basic findings into applied applications. Psychology has taken this path before. In the 1950s, basic research using the Pavlovian and operant conditioning paradigms spawned behavioral technology (e.g., Kazdin, 1989). Basic cognitive psychology is now sufficiently mature that an acceleration in the development of applied cognitive psychology can be anticipated.

It is not enough to establish a training program that is consistent with conclusions derived from cognitive psychology. There are far too many logical ideas that waste time and money. Information processing training must be empirically validated. For instance, leaders taught information processing skills must demonstrate better decision making than leaders without this training.

Training and education are vital but only partial answers to the information processing needs of the modern soldier. The quantity of information produced by the electronic technologies will overwhelm the processing capacities of even the best trained individual. To prevent cognitive overload, future commanders will receive a smaller proportion of the available information. The filtering of information will be a more complex and critical factor on future battlefields. New filtering systems must be developed that balance the need to know and the possibility of overload. Decision makers must have the necessary information but not so much data that their ability to process data is impaired.

Investigations need to be conducted to determine what information should be transmitted via hierarchical networks. The results of these studies should provide the basis for the implementation of electronic information prioritizing. It is anticipated that these filtering devices will sort information according to importance but that the decision maker will have the option of requesting lower priority data.

Filtering systems are only one aspect of information processing. The availability and use of decision-making aids must be expanded. For instance, computers should inform commanders in the field of the probability of particular enemy troop movements.

It is recognized that times of fiscal constraint are not conducive to initiating large new research endeavors. Nevertheless, the urgency for better information processing by military decision makers demands action. The benefits of a 21st century data-gathering system cannot be fully realized until it is matched by a 21st century data-processing system. Data produced will be data wasted until the ability to process information is commensurate with the technology to produce information.

Environmental Stressors

The C2V is not an ideal place to communicate, work, or coordinate activities. Soldiers must confront noise, heat, crowding, confinement, anxiety, and fatigue when the vehicle is stationary. These problems will be magnified once the vehicle is moving.

The influence of environmental stressors would be much easier to predict if their effects were additive. Unfortunately, stressors often combine in ways that are difficult to predict. For example, noise-induced stress typically has a deleterious effect on performance. However, background noise can improve the performance by focusing attention on critical aspects of a task (Houston, 1969). Such findings indicate that the results of single variable stress studies may not be generalizable to settings with multiple stressors.

Research about conjoint effects implies that studying the impact of a stressor in isolation will have little or no applied utility. It is improbable that the influence of stressors on a C2V crew can be determined with reasonable accuracy until the combination of stressors that will exist in the actual vehicle can be ascertained. Then, and only then, should a series of studies be conducted to assess the interaction of that particular combination of stressors with the task variable.

Once the combination of stressors in a C2V is known, a series of experiments should be performed to determine how they affect various tasks. The heart of the design will be the essence of simplicity. Soldiers will perform a task in a C2V or in a relatively stress-free environment. The three task dimensions (simple-complex; low interactivity-high interactivity; solitary-additive) suggested earlier in this report could aid in the selection of tasks to investigate.

Predicting the conjoint effects of stressors is difficult, but the literature does suggest several hypotheses. The C2V environment will have a minimal detrimental or even facilitative effect on simple or highly practiced tasks. The most serious impairments of environmental stressors will be on complex or novel tasks. The interaction of stress and task difficulty creates a particularly serious situation for military teams. Very complex cognitive decisions, such as those made by high ranking commanders, are especially likely to be adversely affected by environmental stressors. Research has also shown that communication and coordination problems are particularly likely to occur in stressful situations. Therefore, highly interactive tasks should be more adversely affected by C2V stressors than less interactive tasks.

It is probable that soldiers will exhibit substantial variability in response to C2V stress. Heterogeneity in the ability of teammates to tolerate stress will influence how the C2V affects tasks on the solitary-additive dimension. Solitary disjunctive tasks require only that a single soldier do well for the group to succeed. Assuming that there is a single competent crew member unaffected by stress, solitary disjunctive tasks should be less affected by the C2V environment than tasks near the additive pole. On the other hand, solitary conjunctive tasks depend on the

poorest performance by a group member. It is likely that some soldier will have particular difficulty coping with C2V environment stressors. The C2V should then have a more detrimental impact on solitary conjunctive tasks than on additive tasks.

STRESS AND LEADER-SUBORDINATE INTERACTIONS

Stress alters how leaders and followers interact and engage in decision making. Authority becomes more concentrated in stressful situations. Research (e.g., Driskell & Salas, 1991) suggests that this centralization of authority is not primarily attributable to leaders who restrict input from subordinates. Instead, subordinates react to stress by curtailing their own input into the decision-making process.

The retreat of followers into their subordinate roles is a potentially significant problem for military teams. Subordinates who actively argue for their positions during training may become quite passive under stress. This reluctance by subordinates could reflect an unwillingness to share in decisions with potentially serious adverse consequences. An alternate interpretation is that subordinates become less involved in stressful situations because they confuse acquiescence to the leader's views with loyalty to the leader. This perception by subordinates is reflective of what Janis called groupthink.

During groupthink, teammates often convince one another of the correctness of the leader's decisions. The danger of groupthink is that it severely restricts the options that the team considers. An unsuspecting leader may believe that all teammates see the merit of his or her views, when he or she is actually the only one thinking.

Groupthink must occur in military situations, although its prevalence is unknown. Typically, after establishing the existence of a phenomenon, the next step is to assess its prevalence. Data about the frequency of groupthink would be valuable, but there is a more cost-efficient research strategy for the Army. Accept that groupthink is a potentially serious problem and focus on its prevention. A number of suggestions (Baron, Kerr, & Miller, 1992; Janis, 1972; McCauley, 1989) have been proposed for counteracting groupthink. These safeguards should be included in leadership courses, and subordinates must be trained not to respond to stress by restricting their input.

1) Open discussion of all alternatives should be promoted.

2) The leader should refrain from advocating a particular plan early in the discussion.

3) The group should examine the likelihood and results of the "worse case" scenario. Plans should be made to minimize losses in case of failure.

4) Outside experts should be brought into the group and encouraged to give their opinions.

MOTIVATIONAL PROCESSES

Motivation is the second of Steiner's two categories of group processes. Team coordination and motivation are usually interactive, not mutually exclusive constructs. Information transmission is the key to effective coordination, but the content of a message can alter motivation. Similarly, stress impacts coordination and motivation. Labeling variables as coordination or motivational often reflects the writer's area of emphasis. Diffusion of responsibility, social loafing, and free riding are several of the motivational variables that are examined in this report. Then, abiding by our custom, research hypotheses will follow from the review of literature.

Cohesion

Group pride, group commitment, "esprit de corps" among group members, group camaraderie, loyalty to the group, bonding of group members, member commitment to a group, and degree of group attraction or liking all describe the group variable of cohesion. Cohesion has been studied in virtually all types of groups such as military units, sports teams, organizations, classrooms, and therapy groups. Cohesion is important because it has a positive effect on group performance (e.g., Dion & Evans, 1992; Evans & Dion, 1991; Mullen & Copper, 1994). In general, cohesive groups are more productive, interact more, communicate more, disagree less, are more satisfied with the group, feel more effective, and make better decisions (e.g., Driskell & Salas, 1992; Fisher & Ellis, 1990; Griffith, 1988; Morgan & Lassiter, 1992; Mullen, Anthony, Salas, & Driskell, 1994; Valacich, Dennis, & Nunamaker, 1992).

The role of cohesion and small group relations in determining military unit performance and motivation has been largely ignored. However, the widespread effects of social alienation among soldiers and degradation of unit identity experienced toward the end of the Vietnam War and the transitional period afterward have emphasized the importance of social and psychological variables (Griffith, 1988). Among these variables, cohesion has emerged as an important factor in military team performance and may be important for the C2V as well. Research has shown that members of cohesive teams are more involved in their team's activities, have lower incidence of

absenteeism, and display more interaction and coordination during team tasks (Morgan & Lassiter, 1992). Cohesive teams also communicate more (Lott & Lott, 1961). Furthermore, Griffith (1988) reports that cohesive Army units are more willing to reenlist in their unit, report higher personal morale, are more satisfied with the Army, and view their units as more combat ready.

Cohesion has been shown to interact with other group variables to influence group behavior. Tziner and Vardi (1982) found that cohesion combined with leadership style to affect the performance of Israeli tank crews in different ways. For example, they showed that highly cohesive tank crews performed best when leaders showed a high degree of concern for both the crew and the task. However, low cohesion crews performed best when leaders showed little concern for the task but a high degree of concern for the crew.

Cohesion is also affected by group size (Mullen & Copper, 1994). Smaller groups are generally more cohesive, more satisfied, and feel more effective than larger groups (Valacich et al., 1982). In addition, Mullen et al. (1994) report that cohesion impairs decision quality as the size of the group increases. Finally, stress can interact with high levels of cohesion and other antecedent conditions (e.g., directive leadership or lack of methodological procedures) to degrade the quality of group decisions in a phenomenon known as groupthink (Janis, 1972).

Researchers interested in the study of cohesion and its effect on group performance suggest that cohesion, like many psychological variables, is multidimensional (e.g., Griffith, 1988; Mullen et al., 1994; Zaccaro, 1991; Zaccaro & Lowe, 1988; Zaccaro & McCoy, 1988). There are at least two dimensions of cohesion, task cohesion and interpersonal or social cohesion. Task cohesion relates to task performance and task commitment, while interpersonal or social cohesion relates to interpersonal support and interpersonal attraction.

Zaccaro and his associates (e.g., Zaccaro, 1991; Zaccaro & Lowe, 1988) have shown that task cohesion is more important than interpersonal cohesion for facilitating performance in additive and disjunctive tasks. Moreover, Mullen et al. (1994) have concluded that improvements in decision quality resulting from cohesion are attributable to the influence of task cohesion. Decreases in decision quality resulting from cohesion, however, are attributable to the influence of interpersonal cohesion. In addition, Mullen et al. (1994) believe that interpersonal cohesion plays more of a role than task cohesion does in the emergence of groupthink. Task cohesion may, in fact, help to eliminate antecedent conditions of groupthink.

Clearly, cohesion and its facilitation will be an important factor in the successful performance of C2V teams. However, there must be an understanding of how the components of cohesion and mediator variables such as leadership will interact to influence C2V team performance. For example, a strict, authoritarian C2V leader may discourage interactions between crew members. By his actions, C2V crews would likely suffer a degradation of cohesion, personal morale, and the level of C2V performance.

There must also be an understanding of how the two types of cohesion contribute to C2V performance. Both components of cohesion appear to be necessary for effective performance (Griffith, 1988). Logically, however, it would seem that task cohesion would be a more important determinant of performance in C2V crews than interpersonal cohesion because C2V crews will be more task oriented than other types of groups (such as social organizations). Therefore, efforts should be made to foster task cohesion in C2V crews such as rewarding cooperative behavior among team members during task performance.

Finally, as our section on groupthink illustrates, C2V leaders and team members must be made aware that too much cohesion, particularly interpersonal cohesion, may have a negative impact on their performance and decision quality. C2V crews must be able to objectively monitor their decision making and performance, particularly during stressful conditions, to avoid setting the stage for groupthink to develop.

Leadership

Leadership and its effect on team performance has long been of major interest to the Army. Despite a wealth of research about the topic (see Stogdill, 1974), the relationship between leadership and performance is not well understood (Hogan, Curphy, & Hogan, 1994). Three areas of leadership research are relevant to military team performance and to the C2V: a leader's personality, skill and ability, and leadership behavior and style.

A leader's personality can have dramatic effects on group behavior. An historical example includes the horrific consequences of Hitler's leadership in Germany from 1933 to 1945, demonstrating that charismatic leaders can be very effective. In general, charismatic leaders are given higher performance ratings by their superiors and higher ratings of greatness by historians; they also produce higher levels of team performance, and their subordinates report greater feelings of satisfaction and morale (e.g., Hogan et al., 1994).

In a more contemporary line of research, Foushee and his colleagues (e.g., Chidester, Helmreich, Gregorich, & Geis, 1991; Foushee & Helmreich, 1988) have demonstrated that a flight crew captain's personality affects the performance of his crew. Crews with captains who were perceived as warm, friendly, self-confident, and emotionally stable made fewer errors than crews with arrogant, egotistical, hostile, boastful, dictatorial, and passive-aggressive captains. This finding is significant because breakdowns in team performance have been a major factor in commercial airline accidents (Cooper, White, & Lauber, 1979; Foushee & Helmreich, 1988).

The skills, abilities, and experience of Army leaders should affect performance. However, a leader's skills and experience appear to affect performance only during certain conditions (Fiedler, 1970; 1990). Potter and Fiedler (1981) demonstrated that there is a positive relationship between a leader's intelligence and performance under low and moderate stress conditions, but that a negative relationship emerges under high stress. Experience seems to mitigate against this effect. More experienced leaders were less likely to be affected negatively by stress. Potter and Fiedler (1981) also found that stress from a leader's immediate supervisor or superior officer affects decision-making performance more than job or task stress does, mainly because "boss" stress focuses a leader's attention on factors irrelevant to the task (e.g., boss's feelings, fear of failure; Fiedler, 1990).

Much has been written regarding the effect of leadership behavior and style on group performance (e.g., Stogdill, 1974). Most studies about leadership style have proposed specific dimensions of leadership such as democratic versus autocratic leadership, permissive versus high control leadership, participative versus directive leadership, and task-oriented versus relationship-oriented leadership. Because leadership in the military (and the C2V) is generally autocratic, we focus our discussion on autocratic versus democratic leadership. Autocratic leadership is most effective in stable, structured situations (Fiedler, 1967), and when subordinates expect to be supervised (Pratt & Eitzen, 1989). Also, teams with autocratic leaders generally perform better than those with democratic leaders. However, teams with democratic leaders generally report more satisfaction with their team than do those with autocratic leaders (Morgan & Lassiter, 1992).

Yet, anyone who has observed leadership in the military and in organizational settings knows that leadership style and behavior are not unidimensional. Effective leaders are never strictly autocratic or democratic, task-oriented or relationship-oriented but vary their behavior, depending on the task or situation, and from one subordinate to another (Yukl, 1989). Effective leaders also show a high concern for both the task and their subordinates (Blake & Mouton,

1976). Concern for subordinates is important because considerate leaders have more satisfied subordinates, and satisfied subordinates are more likely to perform better.

The C2V environment is unique in that soldiers will have to perform command and control (C2) tasks using more automated systems and during varying operational conditions (e.g., continuous operations, moving). These conditions will likely lead to stress for the C2V leader and may alter the leader's behavior. To be effective, C2V leaders must be aware of the impact that stress has on their behavior and decisions and must be trained in strategies that help to reduce or eliminate the negative effects of stress. Effective C2V leaders must also be capable of adapting their behavior to the situation or task and must show regard for their soldiers as well as for the task. It is clear that the C2V leader will need considerable ability, skills, and motivation to be effective.

Duplication of Tasks and the Diffusion of Responsibility

A major problem with hierarchical networks (Figure 1E) is that they are no better than their weakest link. The efforts of an excellent C2V crew can be wasted by an inept commander. Similarly, the C2V commander can only function effectively if subordinates maintain accurate situational awareness.

The most common way of protecting against hierarchical network failures is to duplicate task assignments. Most complex systems achieve redundancy through a combination of human and/or automated safeguards. A copilot checking the captain is the classic example of task redundancy. If the captain's performance is flawless, the copilot's actions are a modest process loss. A small process loss is insignificant if it greatly reduces the probability of an aircraft accident.

Duplication also contributes to the safety and success of military operations. Redundancy of certain tasks is so important that neither the Army nor any other large organization can exist without it. To show how task duplication ideally reduces the cost of an error, assume that two soldiers are trying to locate a target in a series of photographs. In this example, the probability of each soldier not detecting the target is .01 if he or she is working alone.

The likelihood that neither soldier will locate the target is easy to calculate. In mathematical terminology, the actions of the soldiers are independent events. The probability of

the simultaneous occurrence of independent events is equal to their product, .0001 in this instance.

Probability of Error = (Probability A) * (Probability B)
.0001 = (.01) * (.01)

These calculations indicate that rarely will both soldiers fail to detect the target. Unless this is a highly critical task, a .0001 probability of error may be acceptable. However, these computations, like most safety estimations of redundant systems, do not consider group processes. As we will see, soldiers perform very differently when they know that other soldiers are duplicating their efforts.

One probable effect of redundancy is that it influences the degree of responsibility that people feel for their actions. Responsibility is keenly felt when there is no task duplication. Persons in nonredundant settings know that an error on their part will probably have adverse consequences. Assigning multiple soldiers to the same task reduces the responsibility that any individual must bear. Redundancy is often so successful that soldiers recognize that errors rarely pass through the system. Diffusion of responsibility also occurs in redundant tasks because no soldier is solely to blame for any failure.

Hypotheses regarding the effects of diffusion of responsibility in task-redundant systems can be generated by extrapolating from the work of Latané and his colleagues (for review, see Latané and Nida, 1981). Task duplication, because it reduces feelings of responsibility, should result in a decrease in effort. On many tasks, less effort expenditure will cause persons to work far below their potential. Ironically, the detrimental effects of diffusion of responsibility should be greatest when perceived safety is highest. Multiple safeguard systems that appear nearly error free should produce very high levels of diffusion.

The inability of task redundancy to provide the anticipated degree of security led a major airline to experimentally investigate this problem. Harper, Kidera, and Cullen (1971) tested flight crews in a simulator operating during poor weather and visibility conditions. The captain feigned a subtle incapacitation as the plane was making its final approach. An alert copilot had sufficient time to take control of the aircraft and safely land. Nevertheless, approximately one-fourth of these simulated flights crashed.

These simulator crashes were not attributable to a lack of individual skills but to inept teamwork. Several different factors could have influenced Harper et al.'s results. Some copilots

may have incorrectly diagnosed the captain's condition, although this does not appear to have been the reason for most crashes. Even when copilots were unsure about the captain's state, diffusion of responsibility could have created a reluctance to assume command. The implications of Harper et al.'s study are disturbing. Duplication of assignment may not provide the safety that the airline industry and public demand.

Disasters in which "backups" fail to operate are familiar to the military. In April 1994, F-15s destroyed two Black Hawk helicopters over the Iraqi no-fly zone, killing 26 United Nations personnel. The excellent analysis of the accident revealed multiple breakdowns ("Breakdown," 1994). The two F-15 pilots were not told of the presence of friendly aircraft during their pre-flight briefing. Instead, the briefing included an intelligence report about events in Rwanda. The commander of the Airborne Warning and Control System (AWACS) operation was partially trained. By Air Force rules, he was not ready for this mission. One F-15 pilot incorrectly identified the aircraft, failing to notice silhouette and color differences between U.S. and Iraqi helicopters. Both fighter pilots attacked, even though only one apparently identified the helicopters as Iraqi. Finally, the "identify friend or foe" (IFF) systems were not working.

With the possible exception of the IFF, each of these is a human and not an equipment problem. Air Force Major General James Andrus, the chief investigator of the incident, concluded that "this was a breakdown in command guidance and supervision" ("Breakdown," 1994). This is an eminently reasonable assessment. The alternative, which is extremely unlikely, is that the tragedy resulted from an unrelated series of individual failures.

What caused the breakdown in command guidance and supervision? What linked the simultaneous blunders and produced the deaths of 26 people? The identification and understanding of that connection could reduce the likelihood of similar accidents in the future.

The pre-flight briefings officers, the AWACS supervisors and crew, the IFFs, and the F-15 pilots were linked together by a multi-layered task-redundant system. A part of each of their jobs was to ensure that aircraft were correctly identified. Did diffusion of responsibility contribute to the downing of the Black Hawk helicopters? To make a judgment about that issue, let us compare nonredundant and redundant aircraft identification systems.

The performance of a single person determines if an aircraft is correctly identified when there is no task duplication. The decision of a soldier in a redundant system is equally critical, only if all other units have failed. The two situations appear similar, but there is one very

important difference. The individual performing a nonredundant task knows that his decision is critical; there is no rescue if he errs. The person in the redundant system may not realize that all other safeguards have failed. He is alone and does not know it.

The pre-flight officers discussed Rwanda and did not mention the presence of friendly aircraft. Would those officers have held the same briefing if they realized that they, and they alone, could communicate information that would prevent a false identification? Do you think that the supervisor would have assigned the same partially trained airman to the AWACS, knowing that only this airman's good performance could stop the killing of 26 people? Consider the pilot, who made the false visual identification. Was his decision to fire affected by his knowledge that other persons were checking for friendlies in the area? Would the pilot, who did not identify the helicopters, have fired if his teammate did not fire first?

This analysis is not intended to provide a convincing argument for a diffusion of responsibility interpretation. Reasonable people can contend that diffusion of responsibility had nothing to do with downing of the Black Hawks. On the other hand, people cannot be reasonable and argue that poorly managed group processes do not sometimes lower productivity and lead to disaster.

The key word in the preceding sentence is "managed." Diffusion of responsibility is not an inescapable product of task duplication. Social variables are predictable and controllable, just as are nonorganic physical variables. Task redundancy per se was not the problem with the aircraft identification system in Iraq. The problem was that duplication was instituted without an understanding of the social processes it was creating.

The actual safety of task-redundant systems can be enhanced by the systematic application of group process variables, making accidents such as the Black Hawk helicopters less likely. Social process management techniques, which should be incorporated in all important task-redundant systems, are described later in this report. But first, additional group process variables are examined.

Social Loafing

In a classic study, Ringelmann (1913) found that persons pull a rope harder when working as individuals than as members of a team. From Ringelmann's data, it is impossible to determine if process loss was attributable to poor coordination, motivational deficits, or a

combination of the two. Ingham, Levinger, Graves, and Peckham (1974) designed a clever experiment that separated motivational effects from coordination effects on the rope pull task. They accomplished this by leading subjects to believe that they were a part of a team when they were really the only person pulling on the rope.

Ingham et al. found that subjects who thought that they were part of a group pulled less hard than subjects who knew that they were alone. Moreover, the larger the group was purported to be, the less hard they pulled. Ingham et al. demonstrated that at least part of Ringelmann's effect resulted from motivational process loss.

Latané, Williams, and Harkins (1979) called this reduction in effort "social loafing." Social loafing, Latané (1981) contended, results from diffusion of responsibility. Subsequent research has shown that this type of motivational loss is a widespread problem. Group members loaf during cognitive (e.g., Petty, Harkins, & Williams, 1980) as well as motor tasks. Social loafing is also not solely a product of western cultures. Investigators have reported social loafing with Japanese (Williams & Williams, 1984), Taiwanese (Gabrenya, Wang, & Latané, 1981), and Asian Indian (Weiner, Pandy, & Latané, 1981) subjects.

Social loafing, like most group process, depends on the task. Intrinsically interesting tasks (Petty, Cacioppo, & Kasmer, 1985) or tasks that people are personally involved in (Brickner, Harkins, & Ostrom, 1986) are unlikely to produce social loafing. Permitting members to help establish group goals (Brickner, 1987) or develop high levels of cohesion (Williams, 1981) also counteracts social loafing.

Davis' (1969) distinction between information-conserving and information-reducing tasks is useful for predicting the occurrence of social loafing. Information-conserving tasks do not produce loafing because the input of individual members is known. Social loafing is restricted to information-reducing tasks, in which no member's performance is identified. Anonymity appears to be the essential element of social loafing because it prevents individuals from being evaluated (Harkins, 1987; Harkins & Szymanski, 1987).

Thus, social loafing is most likely to develop when low cohesive groups attempt boring tasks and the distinct contributions of each member are not evaluated. The Army can sometimes expect interest in the task itself to prevent loafing. Social loafing is unlikely during Janus simulations because most students become intensely involved with the task. Unfortunately, no

rational person would find some Army tasks interesting. Efforts by the Army to build cohesion and esprit de corps probably have the salutary effect of countervailing social loafing.

Task interest and cohesion give some protection but are often inadequate security against social loafing. The main cause of social loafing in many military groups is a lack of personal accountability. Discovering a soldier willing to acknowledge responsibility for a task is sometimes a mystifying exercise. In some instances, there seems to be no individual in charge and the lines of responsibility resemble a labyrinth.

Diffusion of responsibility or social loafing is also exacerbated by the tendency of some subordinates to pass responsibility to a higher ranking officer with startling rapidity. It is a probable but untested hypothesis that organizations with little or confused accountability produce people who are more concerned with avoiding mistakes than doing something right. An unwillingness to take responsibility could be attributable to timidity or confusion, but it is often a form of social loafing. The pretense of "being a good subordinate" can be an effective disguise for social loafers.

Evaluating the team but not each member's contribution is a common practice that further reduces accountability. On many tasks, especially disjunctive ones, a team may succeed despite the poor performance of individual members. Duplication of task also hides failure. Many of the problems that led to the Black Hawk tragedy may have gone unnoticed if even one part of the system had worked. Unidentified failures are usually repeated. Without accountability, social loafing will grow, potentially culminating in multiple failures by teammates.

Social loafing can be seen as a shortcoming in the individual or as a deficit in the social environment. As individuals, soldiers are probably neither more nor less likely to loaf than the general populace. Some soldiers are certainly more prone to loafing than others. Everyone has had a friend who had a friend, who knew a soldier, who was a loafer. Focusing on an individual's foibles can have some benefits but is an expensive and not always productive enterprise. Modifying the social environment is often a more cost-efficient strategy for large organizations.

Social loafing is symptomatic of an underlying organizational flaw or disease. That disease is an ineffective evaluation system. There is little value in telling a loafer that he or she has a social disease, but much is to be gained by changing evaluation procedures.

This is not so much a call for more evaluation as it is for better evaluation. Consider this familiar scenario. A soldier's performance is evaluated using a paper-and-pencil rating scale. Probably neither the evaluator nor the evaluee can describe how these ratings are related to job performance. This is not surprising, because many evaluation instruments are not empirically validated. There may be no data indicating that soldiers who obtain a "4" on the "cooperative" scale are any better or worse radio operators than soldiers who receive a "2."

Recognize that the main problem in this example is not using rating scales but reliance on measures that have not been validated. Rating scales often provide valuable scientific data but only when the scales are statistically associated with some important metric such as job performance. Assessment instruments not subject to validity testing must be regarded as purely subjective evaluations with all the well-known weaknesses of that endeavor (Gregory, 1992).

The main alternative to subjective assessment is an expansion of the Army's efforts to implement criterion-referenced evaluation. Soldiers should be assessed on those behaviors that are either a part of their job or empirically related to their job. Good performance assessment requires the determination of the correlation between the evaluation item and the job activity. For instance, a C2V crewman cannot be evaluated until it is known what information should and should not be sent to a superior and how and to what extent the crewman should summarize and interpret the data. The movement away from subjectivity and toward more objective evaluations will have a number of performance and training advantages, including a decline in social loafing.

Free Riding

The first author of this report painted apartments to earn money for college. The best worker on the author's painting team was the "snowman," so called for the incredible speed with which he put white paint on walls. The other member of the author's team was universally referred to as "Houdini," because he disappeared when work needed to be done.

Each day the snowman performed Herculean feats, the author struggled (somewhat unsuccessfully) to do his part, and Houdini moved at a barely measurable pace. Then one day, the snowman fell sick from the flu. The prospect of performing an already disagreeable job with only Houdini to help was infuriating. Astonishingly, a new Houdini emerged. He painted more rapidly than the author and worked with previously unseen cheerfulness. For 5 days, Houdini continued to defy expectations. The snowman returned the following week and so did the old Houdini.

Before his amazing week of work, the author assumed that Houdini's incompetence reflected a lack of ability or just laziness. This assessment greatly underestimated the complexity of the situation. Houdini was a skillful painter and was not always afraid of work. The key to Houdini's work habits was the presence of the snowman. Houdini worked far below his potential when the snowman was on the job, an extreme case of process loss.

Profiting from the group's efforts without attempting to help the team achieve its objective is called free riding (Kerr, 1983; Olson, 1965). Free riding is a violation of the social norm that individuals must work for the team's benefit (Tajfel, 1970). The author conformed to that norm, struggling to maintain a satisfactory pace. Houdini blatantly rejected this norm, leading group members to believe that they were being cheated. It is likely that his derogatory nickname was originally an attempt by group members to shame him into carrying his load.

It is important to realize that free riding and social loafing have distinct causes. Evaluation systems that do not assess the contributions of individual members produce social loafing. Social loafing can be eliminated by making each member's performance fully identifiable (Kerr & Bruun, 1981; Williams, Harkins, & Latané, 1981). In contrast, the inadequate performances of Houdini and other free riders is very obvious. Houdini never tried to hide his lack of effort. He appeared to wear his nickname as a badge of rebellion and honor.

The sudden turnabout during the snowman's illness shows that dispensability (Kerr, 1983; Kerr & Bruun, 1983) has a prominent effect on free riding. Houdini would have missed his favorite evening entertainments if he did not help the author complete the daily quota of apartments. He had to stop free riding for the team and for himself to succeed.

Dispensability and, hence, free riding depend on the type of task. In general, solitary tasks on the solitary-additive dimension are most likely to produce free riding. Which team member will free ride depends on whether the task is conjunctive or disjunctive (Kerr & Bruun, 1983). Assume that a soldier believes that he or she is the fastest jogger in his or her platoon. The group cannot shower until all platoon members have jogged four laps. The fast jogger's performance will have little consequence to the team on this conjunctive task. It is improbable that he or she will be the last to finish, even if he or she does not try his or her best. He or she can free ride with little or no cost, given that his or her only objective is to take a shower. Disjunctive tasks will promote free riding but in a different group member. Now, the whole group can shower when the first person completes four laps. Slow joggers can leisurely trudge

along, their input quite dispensable, contentedly free riding on the efforts of their fleet teammates.

Group size also affects free riding, especially on those tasks at the solitary pole of the solitary-additively determined dimension. The probability that a member's efforts will affect the team's productivity is very small with large groups performing conjunctive or disjunctive tasks. Many members realize that their input is dispensable and take a free ride. Additive tasks, in which all members' efforts influence productivity, are much more resistant to the effects of group size.

Free riding and social loafing have different causes but similar remedies. It is plausible that high group cohesiveness decreases free riding, although no studies to verify this proposition have been found. Designing tasks to be near the additive pole of the solitary-additive dimension is an effective strategy for reducing free rides. The difficulty with this approach is that not all tasks can or should be additively defined.

Harkins and Petty (1982) demonstrated that free riding, like social loafing, is affected by accountability. Subjects performed a vigilance task, watching for flashing dots on a computer screen. In one condition, each subject was solely responsible for the dots on a particular section of the screen. This was basically an additive task; little free riding was predicted or observed. The task was defined disjunctively in a second condition; the group received credit if any member noticed the dot. The opportunity to free ride was available in this arrangement and taken by many. In a third condition, the task was disjunctive, but teammates were aware of one another's performance. Disjunctivity presented the chance to free ride, but identifiability meant that teammates would be aware of a lackluster performance. Making individual member input identifiable decreased free riding. This suggests that the Army can use identifiability to reduce free riding when it is not possible or appropriate to employ additive tasks.

An argument can be made that free riding is not usually a significant source of process loss. Members are most likely to free ride when their efforts will have little or no impact on the team's productivity. What is wrong if a member with high ability free rides on a conjunctive task? Similarly, what problem will result if members with low ability are permitted to free ride on disjunctive tasks?

Asking a group of students a question about a multiple launch rocket system (MLRS) is a disjunctive task. A single correct answer ensures group success. Group productivity will not be

affected if a student, who knows little about the MLRS, daydreams in the back of the room. The team is currently immune to free riding by the daydreamer, but will this incident have subsequent deleterious consequences? Research is silent about this issue.

Is free riding a debt that the rider or team must pay later? Subtle costs are not difficult to imagine once the possibility of their existence is acknowledged. Perhaps the daydreamer will be oblivious to an answer that could help him perform his MLRS duties? More importantly, if "harmless" free riding is frequent, will it generalize to situations where the member's input impacts team productivity? How will a person who free rides on a series of disjunctive or conjunctive tasks respond to an additive task? This issue definitely merits empirical assessment. There is a very real prospect that Army leaders, with only an intuitive feel for group processes, often create free riding training grounds.

A very astute reader may have recognized that the case of Houdini is inconsistent with the free riding literature. Accountability is high in apartment painting, because each member can accurately estimate the amount of work that his or her teammates accomplished. The task was additive; the effort of all team members determined when the day's job was done. No member's work was dispensable. Free riding should be kept to a minimum during these conditions.

Actually, the free riding literature predicts the behavior of most apartment painters quite well. Blatant free riding was rare. Why then, did Houdini free ride so extensively? The answer is, in part, that he was an efficiency expert. Houdini knew more about efficiency than almost every highly paid efficiency consultant. That statement warrants some elaboration. It will soon be addressed, but first, the research about equity must be considered.

Houdini: The New Douglas MacArthur

Many World War II Pacific veterans owe their lives to Douglas MacArthur's tactical brilliance. MacArthur's strategy brought a steady advance toward Japan with relatively little loss of life. From the time MacArthur arrived in Australia until V-J Day, fewer than 28,000 of his men were killed. More Americans died at Anzio and at the Battle of the Bulge than under MacArthur's command (Manchester, 1978).

A lifetime of achievement made MacArthur one of America's most decorated soldiers. Twenty-two of his medals were for bravery, including the Medal of Honor. MacArthur was a true American hero and the nation responded with adulation. MacArthur's

prestige was so great that his dismissal by Truman during the Korean War produced a crisis for that administration (McCullough, 1992).

The senior author recalls listening to a group of Pacific veterans discuss MacArthur. Here, among the men he commanded, should be MacArthur's most enthusiastic admirers. Surprisingly, each of these veterans detested MacArthur. "He didn't win the war alone" and "nothing but a damn glory hog" summarized their opinions. They acknowledged MacArthur's contributions, implicitly recognizing the debt they owed him. Nevertheless, not one of this group would have voluntarily loaned MacArthur a match to light his pipe. What did MacArthur do to cause such hostility?

Houdini and Douglas MacArthur share one important characteristic. Both men were perceived by their teammates to have violated the equity norm. The equity norm holds that the ratio of input to output should be equal for all comparable group members (Adams, 1965). Houdini was getting the same output (rewards) as other group members, but his input (effort) was much lower.

MacArthur's inequities were more complex. His input (tactics) was valuable, but other servicemen and women also helped defeat the Japanese. The equity norm entitled MacArthur to a large share of the rewards. His violation was that he was perceived to claim all the rewards. Some Pacific veterans felt that MacArthur denigrated their own achievements by "hogging the glory." Wise leaders recognize that personal aggrandizement is a costly indulgence. The naive commander refers to "my battalion"; the wise commander refers to "our battalion."

Group members often respond to equity breaches with efforts to make the transgressor abide by the norm. Often, these efforts are ineffectual, leaving team members with an avoidance-avoidance situation (Lewin, 1938). Members can continue to work for less reward than they warrant, becoming "suckers" of undeserving teammates. Alternatively, they can restore equity by reducing their own efforts. For example, the snowman could have established equity by decreasing his output to match that of Houdini. The problem with this strategy is that all team members receive less reward. The reduction in input to avoid exploitation by teammates is called the "sucker effect" (Kerr, 1983).

A potentially serious problem is that attempts to establish equity can initiate a downward spiral in the performances of many group members. One free rider may lead a worker to decrease input, which may cause a third member to reduce efforts. Eventually, the efforts of

most members may decline, making the group very unproductive. "One bad apple spoils the barrel" is a familiar maxim that summarizes this type of process loss.

Not all inferior performances by group members are perceived as inequitable. Equity is assessed in terms of a member's ability to produce desirable input. For instance, Gergen, Ellsworth, Maslach, and Seipel (1975) found that a donation of $100 from a poor person is considered more charitable than an equal donation from a rich one. Sucker effects are more likely to be observed when a poor performance is attributed to a lack of effort instead of to inability (Kerr, 1983).

Favoritism unrelated to achievement is a common violation of equity. In 1869, General Philip Sheridan committed a long-remembered equity infraction at what is now Fort Sill, Oklahoma. A ceremony was planned in which the fort's first stake would be hammered into the ground. As Sheridan knelt to hold the stake, several eager officers stepped forward to assist the General. Sheridan ordered them away and called for a young ambulance driver, Johnny Murphy. There was speculation that Murphy was selected to drive the stake because he and Sheridan were both Irishmen (Nye, 1988). Nineteenth century job advertisements (Furnas, 1969) often ended with the stipulation, "No Irish Need Apply." Sheridan had his own selection criterion, "Only Irish Need Apply."

Hopefully, you realize that this assessment of Sheridan could be unfair. His reason for honoring Johnny Murphy may have been unrelated to his ethnic background. From an equity standpoint, it does not matter if Sheridan was biased. Perceptions of inequity stimulate a response, even if those perceptions are invalid. Machiavelli ([1513]1952) recognized the importance of this distinction in the 16th century. In *The Prince*, he stressed that it is often more important for leaders to be seen as just than to actually be just. Subordinates do not respond to what a leader does but to what a leader is perceived to do.

Perceptions of equity vary with the individual's circumstances. New workers often feel unjustly treated because they receive less money for the same job than senior workers (e.g., Premeaux, Monday, & Bethke, 1986). Satisfying new workers with equivalent salaries would be regarded as inequitable by many senior employees. Senior employees tend to believe that longevity should be monetarily honored.

A decrease in effort is not the only way that a member can respond to a perceived inequity. Equity can be reestablished by a decline in the quality of input (e.g., Evan & Simmons,

1969). The member may produce the same quantity of work but make more errors. Quitting the job is a drastic means of escaping an inequitable situation sometimes used by civilians (e.g., Valenzi & Andrews, 1971).

Distortions of reality (e.g., Walster, Walster, & Berscheid, 1978) are a common means of achieving equity. Many soldiers probably believe that good work on their parts will guarantee that their careers advance. In reality, factors beyond the individual's control affect progress in all professions. The comforting illusion that people invariably get what they deserve is called the "just world hypothesis" (Lerner, 1970). The anxiety reduction gained from the just world illusion can be costly. For instance, an employee may continue to work hard for promotion, denying to himself or herself that he or she is in a "dead end" job. His or her professional aspirations might be furthered if he or she rejected the just world hypothesis and sought other employment.

The research about attributional biases (e.g., Zuckerman, 1979) suggests that equity-induced distortions will often be self serving. When objective evidence is lacking, a plunge into subjective attributions can justify a current or anticipated reward. For example, a university professor applied for promotion with little objective support. His teaching evaluations were poor, he did not publish, and rarely did he help with committee work. When asked why he deserved promotion, he responded, "character." He believed that his character, an attribute he never attempted to describe, entitled him to a promotion.

A desire for subjective evaluation is not restricted to characters like this professor. Almost all persons occasionally wish for the vagueness of subjectivity. Subjective assessment can be condemned because it is the refuge of malingerers and incompetents. Often forgotten is that subjectivity gives sanctuary to the wounded, a dream place where all can award themselves prizes. Justice and kindness are not synonyms.

Investigations have demonstrated conclusively that attempts to achieve equity can lower group productivity. There is another less researched side of equity. Equity theory predicts that people who are getting more than they deserve should experience pressure to augment their output. For instance, workers who are overpaid relative to other group members can attenuate inequity by working harder (Goodman & Friedman, 1971; Pritchard, Dunnette, & Jorgenson, 1972). Also, people lacking qualifications can compensate by exerting more effort than their coworkers (Adams, 1963; Adams & Rosenbaum, 1962).

Reward Efficiency and Equity

Most purposeful actions are not simply attempts to gain a reward or achieve an objective. The goal of even many basic behaviors is to obtain a reward with the least possible effort. People do not usually attempt to open doors with their full strength. Similarly, most persons would prefer to use a wheelbarrow than to carry large rocks on each shoulder. Reward efficiency (RE) is one of the most prevalent of human motives. In mathematical terms, the object of RE is to maximize the ratio of reward to effort.

$$\textit{Reward Efficiency} = \frac{\textit{Reward Units}}{\textit{Units of Effort}}$$

Persons working alone must rely on their own initiatives to raise their RE's. In contrast, group members frequently augment their RE's by attaching themselves to superior teammates. Houdini obtained the same rewards (salary) as his coworkers and expended much less effort. His RE value was much higher than the snowman's or the author's. Houdini was the true efficiency expert of our group.

The purpose of the equity norm is to discourage parasites like Houdini. Transgressors are usually severely punished. Houdini lost friends, was bored with his work, and became the laughingstock of the apartment painters.

Despite the threat of retaliation, the pursuit of RE often leads to equity violations. Reward efficiency is the common denominator of diffusion of responsibility, social loafing, and free riding. In each of these conditions, a group member exerts little effort yet retains a substantial share of reward.

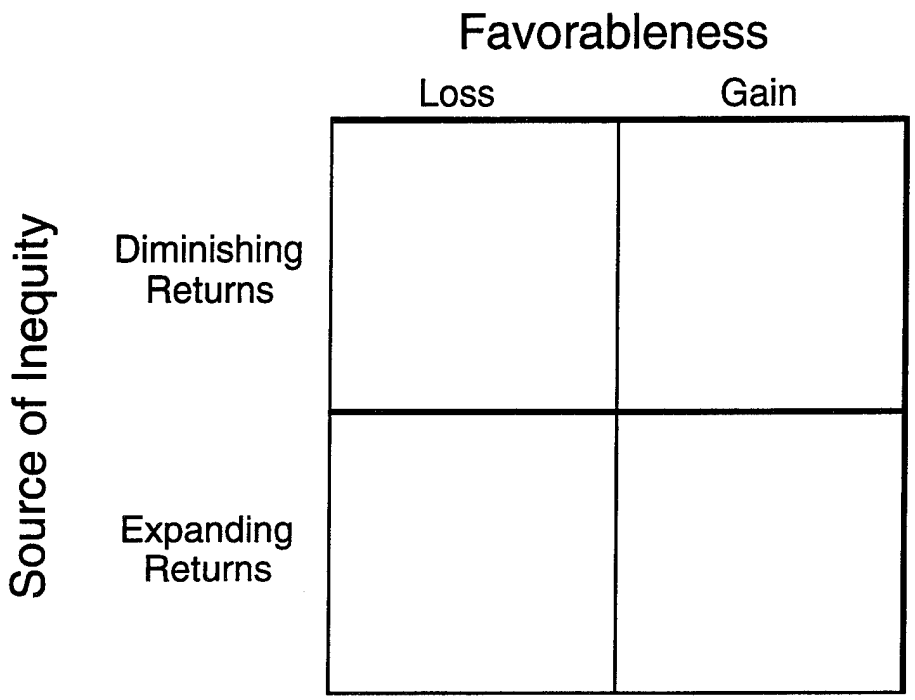
The following analysis extends equity theory by adding RE as a motivational component. Reward efficiency and equity are assumed to operate concurrently whenever rewards are distributed among group members. This dual motivational theory generates a number of hypotheses that would not be derived from equity theory. These predictions will have important implications for the motivation of military teams if they are confirmed by subsequent research.

Dual motivational theory holds that the combined effects of RE and equity depend on the favorableness and the causes of the inequity. Favorableness indicates whether the member

benefits or suffers from the inequity. There are two essential causes or ways of producing inequities. Some inequities occur because the more effort members exert, the less reward they receive per unit of effort. This type of inequity will be called diminishing returns. Expanding returns is when the more effort members exert, the more reward they obtain per unit of effort. The four conditions of this dual motivational theory are depicted in a 2 x 2 table (see Table 2).

Table 2

The Dual Motivational Model



Note. Loss and gain refer to whether the individual suffers or benefits from the inequity.

A dyad will be used to show how dual motivational theory predicts the response of group members to inequity. Most tasks are affected by ability and effort, but to simplify matters, teammates will be accorded equal abilities. In each of the following examples, Member A produced 8 units and Member B 12 units of effort. Equity exists when each teammate earns the same amount reward for each unit of effort. The equation below reveals an equitable distribution of 400 reward units. Each unit of effort produces 20 reward units; Member A received 160 reward units and Member B 240 units. In a dyad, equity is achieved when the RE of both members is equal.

$$\frac{\textit{Reward Units}_A}{\textit{Units of Effort}_A} = \frac{\textit{Reward Units}_B}{\textit{Units of Effort}_B}$$

$$\frac{160}{8} = \frac{240}{12} = 20$$

$$\textit{Response Efficiency}_A = \textit{Response Efficiency}_B$$

No equity pressures should exist in this situation unless members perceive their own efforts and rewards differently than those of their teammates. Similarly, the opportunity to increase RE will not be available if the ratio of reward units to effort is firmly set.

One of the most common ways of producing inequity is for teammates to equally share rewards. For example, monetary earnings may be evenly divided, an entire team may be praised, or all members can stop working when the job is completed. The essential characteristic of this type of inequity is that the more effort people expend, the less reward they will obtain per unit of effort. The equation below shows an equal (200 units per member) but unequitable distribution of rewards. An equitable situation would exist if Member A received 160 reward units for the 8 units of effort expended and Member B received 240 reward units for the 12 units of effort expended. However, as can be seen, Member A's reward is 40 units greater than equity and Member B's reward is 40 units less than equity.

$$\textit{Response Efficiency}_A = \frac{\textit{Reward Units}_A}{\textit{Units of Effort}_A} = \frac{200}{8} = 25.00$$

$$\textit{Response Efficiency}_B = \frac{\textit{Reward Units}_B}{\textit{Units of Effort}_B} = \frac{200}{12} = 16.67$$

Attempts to establish equity theory should lead Member A to increase effort and Member B to decrease effort. The drive to maximize the reward-to-effort ratio should cause future effort reductions by both Members A and B.

Dual motivational theory allows for equity and RE to have either complementary or counteracting effects. The effects should be complementary for Member B; both motivations

lead to a reduction in effort. In contrast, equity and RE have counteracting influences on the effort exerted by Member A.

The factors that determine the relative weightings of equity and RE are not currently known. Therefore, dual motivational theory does not predict the overall directional effects of the inequity on Member A. It is probable that substantial individual differences exist in the weighing of RE and equity. Some persons, like Houdini, are more affected by RE than equity. When RE is the primary motive, reduced effort or free riding will occur if the inequity is caused by diminishing returns. Alternatively, individuals mainly motivated by equity should augment their efforts.

Dual motivational theory hypothesizes that inequity will have a greater impact on the performance of Member B than Member A. This prediction is consistent with an important and reliable finding in the equity literature. Efforts to restore equity are much more difficult to produce in overpaid than underpaid members.

You will recall that distortions allow overpaid members to maintain a high level of reward without expending additional effort (Walster, Walster, & Berscheid, 1978). This interpretation is consistent with dual motivational theory. Over-valuing one's input is simply one way that excessively rewarded people keep the ratio of actual rewards to effort high.

Equity research has focused on diminishing returns, that is, inequities in which high responders receive fewer rewards per unit of effort than do low responders. An important benefit of dual motivational theory is that it directs research to examinations of inequities resulting from expanding returns. Many societal inequities occur because the more effort members exert, the more reward they obtain per unit of effort. For instance, compare major league baseball players with .300 and .250 batting averages. The .300 hitter's average is 20% higher than the .250 hitter's average. However, the .300 hitter's salary is probably more than 20% greater than the .250 hitter's salary. The .250 hitter anguishing from inequity may be making an embarrassingly small salary of only $1,000,000 per year.

A more serious example is the accumulation of wealth by social classes in the United States. Assume that two families each require and spend $30,000 per year to maintain a middle class lifestyle. The annual incomes of the families are $40,000 and $32,000. The ratio of incomes is 5 to 4. However, the first family can invest or save $10,000 and the second family only $2,000, a 5 to 1 ratio. If this situation persists, the economic well-being of the two families will increasingly diverge over time.

There are many ways that expanding returns can be generated. Some companies enhance motivation by increasing commission rates as sales grow larger. A salesperson may receive 10% for the first $100,000 of sales and 15% for the second $100,000. The example of diminishing returns overpaid Member A by 400 reward units and underpaid Member B by 400 reward units. This example of expanding returns will underpay Member A by 400 units and overpay Member B by 400 units. The authors are highly motivated by equity concerns.

$$\textit{Response Efficiency}_A = \frac{\textit{Reward Units}_A}{\textit{Units of Effort}_A} = \frac{120}{8} = 15.00$$

$$\textit{Response Efficiency}_B = \frac{\textit{Reward Units}_B}{\textit{Units of Effort}_B} = \frac{280}{12} = 23.33$$

The motivation to achieve equity should lead Member A to increase effort and Member B to decrease effort. Notice that equity theory makes the same predictions for equities resulting from diminishing and expanding returns (see Table 3). Expanding and diminishing returns make opposite predictions for RE. Inequities produced by expanding returns should augment efforts by both Members A and B.

Table 3

Effort Changes Predicted from Equity, Reward Efficiency, and Dual Motivational Analyses

Diminishing returns inequity		
Equity	Reward efficiency	Dual motivational
1) LI increases 2) HI decreases	1) LI decreases 2) HI decreases	1) LI weak effect 2) HI decreases
Expanding returns inequity		
Equity	Reward efficiency	Dual motivational
1) LI increases 2) HI decreases	1) LI increases 2) HI decreases	1) LI increases 2) HI weak effect

Note. LI = low input; HI = high input.

Dual motivational theory hypothesizes that equity and RE will have complementary effects on the motivations of Member A. Expanding returns should then augment the effort exerted by Member A. Equity and RE will have counteracting effects on the motivation of Member B. Dual motivational theory does not predict whether equity or RE will have the stronger impact on Member B. It does predict that the effects of the inequity on Member B's efforts will be less than on Member A's efforts.

Applied Utility of Dual Motivational Theory

Hypotheses based on dual motivational theory indicate that the prevalence of unproductive members will depend on how rewards are portioned. When rewards are divided according to a diminishing returns formula, the motivation to maximize the reward-to-effort ratio will cause frequent breaches of the equity norm. Diffusion of responsibility, social loafing, and free riding often result from diminishing returns distribution systems. Punishment of the transgressor by leaders or other group members is the way free riding is usually controlled in diminishing returns systems.

The RE motivation should make low effort performances unlikely when productive members receive more reward per unit of effort than do nonproductive members. Free riding is not possible in an expanding returns system, because reductions in effort hurt the individual member more than the team. A better name for people who attenuate their efforts under expanding returns, is "foot shooters." Low effort performances are more likely to emerge under diminishing than expanding returns because most people are more willing to take a free ride than shoot themselves in the foot.

The beauty and complexity of social relationships is that they are reciprocal. The bi-directional influence and mutual exchange of information among group members can have multiplicative effects. If the initial free rider is not forced to conform in a diminishing returns system, other group members may attempt to restore equity by reducing their own efforts. Leaders often try to thwart the downward spiral of group effort by raising the rewards of productive members. The hope is that soldiers will be less likely to decrease their efforts if they believe that promotions, remaining in the Army, praise, and other rewards depend on their input.

Stopping the spread of nonproductivity is an important but limited objective. Neutralizing the impact of a social process on team performance is similar to entering a poker game hoping to split even. If mishandling of reward distributions can cause a downward spiral in

team productivity, why cannot a well-managed use of reward distributions initiate an upward performance spiral?

How do you harness group processes to initiate the upward surge, make the efforts of one member build on another, systematically turn contagion on and off? The answer to these questions is suggested by dual motivational theory. If rewards are fixed and expanding returns are employed, increases in effort will raise the member's RE and total rewards. Elevations in the efforts of one member also reduce the RE and total rewards of other members. To remain at their previous level, the second member must then augment his or her effort. The first member is then pressured to further enhance effort and the upward spiral of activity begins.

Expanding returns should drastically reduce low effort performances and sometimes stimulate an upward spiral of activity. These benefits will almost certainly be achieved at a cost. Placing teammates in competition with one another for rewards will not foster liking and could impair communication between teammates (Sherif, 1966). Also, on tasks with a strong ability component, less talented members may be unwilling to expend any effort, given the very low rewards that they would receive.

The selection of reward systems has a powerful effect on the motivation and cooperation of members of military teams. Empirical studies of how the distribution of rewards affects group members will significantly enhance our understanding of the determinants of team motivation and productivity. The accumulation of knowledge in this area will allow a more systematic and less haphazard choice of reward distribution plans. Dual motivation theory is presented as a guide for some of that research.

REFLECTIONS AND PROJECTIONS

This concluding section considers traditional explanatory constructs and their effects on our understanding of social behavior. Traditional attributions of group behavior are then compared to scientific interpretations. The following assessment of causality was strongly influenced by Skinner (1971). However, as our preceding use of intervening variables indicated, we are not radical behaviorists.

Throughout most of human existence, people believed that inorganic and organic events were caused by the same types of phenomena. Animism or the belief that spiritual entities inhabit all objects typifies early cultures. The ancient Greeks attributed lightning to Zeus and

thought that gods often imbued people with jealousy, bravery, and other emotions. Aristotle saw a world populated by what Skinner called invisible movers. For instance, Aristotle postulated that falling bodies accelerated because they became increasingly jubilant as they neared home.

Zeus and jubilation in falling objects are exemplars of what we will call opaque explanations. They are opaque because they prevent the passage of light or knowledge. Opaque explanations have the following characteristics:

1) There is no evidence for their existence. No one actually located jubilation in a lead ball or caught Zeus hurling a thunderbolt. Nevertheless, millions of our ancestors claimed that they observed these events.

2) Opaque explanations are invented when people do not know the cause of an event that they consider important. People often find unanswered questions aversive. They frequently hide their lack of knowledge from themselves and others with opaque attributions.

3) Social consensus, rather than objective reality, is the basis for opaque explanations. Most people accept what they are told without question. Only a rare individual will consider the validity of a belief that all his or her associates hold to be true. Popularized foolishness often persists for centuries because it is so popular.

4) People often become upset when opaque explanations are questioned. The reason for this is that they know that opaque interpretations are based on social and not objective reality. Anger is seldom directed against persons who deny objective reality. We pity a person walking in a storm who claims it is not raining. In contrast, denying that Mohammed moved a mountain or that Picasso was creatively inspired can incite the wrath of admirers of Mohammed and Picasso.

5) Many opaque explanations involve nonphysical entities that cannot be proved or disproved. The existence of Zeus and jubilation in objects was never disproved. These and other opaque explanations often have long lives because their validity cannot be tested. Opaque explanations only slip from fashion when more useful explanations (e.g., electricity, Law of Falling Bodies) become available.

6) Opaque explanations are frequently circular. Consider the following fictional conversations from ancient Greece.

Unaware Greek: What causes lightning?
Aware Greek: Lightning is caused by Zeus throwing his thunderbolts.

(Several days later, the electrifying discussion continues.)
Unaware Greek: What is Zeus doing now?
Aware Greek: He is throwing thunderbolts?
Unaware Greek: How do you know that he is throwing thunderbolts?
Aware Greek: Because it is lightning.

Now contemplate the following conversations, which will occur next month in a leading American university.

Unaware Student: Why did Hitler believe that he could move into the Rhineland, take over Austria and Czechoslovakia, conquer the remainder of Europe and dominate the world?
Historian: Because Hitler had delusions of grandeur.

(Several classes later, the enlightening discussion continues?)
Unaware Student: How do we know that Hitler had delusions of grandeur?
Historian: Because he moved into the Rhineland, took over Austria and Czechoslovakia, tried to conquer the rest of Europe, and planned to dominate the world.

7) Zeus and jubilation would be humorous antiquities if they did not inhibit the advancement of knowledge. Once a "cause" is determined, inquiry usually ceases. The "discovery" of a Zeus or jubilation cannot be refuted, so they often inhibit the pursuit of knowledge for many years.

Physics eventually cast aside Zeus, jubilation, and other opaque concepts. Only after opaque explanations were proscribed could physics develop into a modern science. All emerging sciences exiled opaque explanations as a prerequisite for their advancement. Astronomers eliminated the astrologers, chemists stood apart from the alchemists, and biologists banned the vitalists. Science and opaque explanations are incompatible; they never have been and never can be brought together in a cohesive whole.

The domain of opaque explanations has steadily receded as human knowledge has expanded. Despite their retreat, intelligent people still attribute the causes of human behavior to opaque constructs. Consider this statement:

"Responding to the inspirational leadership of General Patton, his men fought valiantly at the Bulge."

This opaque explanation holds that "inspirational leadership" caused Patton's soldiers to behave in a particular manner. What does the phrase "inspirational leadership" mean? "Inspirational leadership" could refer to something inside of Patton. If "inspirational leadership" dwells within Patton, is it something physical? Perhaps, Patton had a big medulla and less inspirational leaders have tiny medullae. General Patton may have concurred regarding his anatomical superiority, but we know of no confirming physiological measurements.

This may seem unfair. Most people feel that inspiration is incorporeal, lying somewhere beyond the senses. If inspiration is incorporeal, how was the writer of this sentence aware that this beyond-the-senses thing settled into Patton? Is the writer claiming extrasensory perception (ESP)?

The writer would probably be unwilling to publicly claim to be clairvoyant. Most people who use terms like "inspirational leadership" never thoughtfully consider what they are talking about. They do not ponder if inspiration is internal or if it is physical or intangible entity. "Inspirational leadership" is just a phrase many people use to describe superiors when subordinates exhibit certain behaviors. "Inspirational leadership" may have nothing to do with Patton but redescribes the actions of his soldiers. Why did Patton's men fight valiantly? Because he was an inspirational leader? How do we know that Patton was an inspirational leader? Because his men fought valiantly.

The most optimistic interpretation of this sentence is that "inspirational leadership" refers to some behaviors emitted by Patton. "Inspirational leadership" could be the writer's verbal endorsement of Patton's methods for training the Third Army. If that is the case, why did not the writer just say so? Why speak in vague mysterious terms and let the audience guess the intended thought?

We began this examination of opaque explanations with a little laugh about Aristotle. This was a safe jest. Aristotle is dead and can hardly object and his current followers are much less violent than they were several centuries ago. Jubilation of falling bodies seems preposterous after 25 centuries of accumulated knowledge. However, we may have laughed too soon. Jubilation and Zeus have overtaken us, disguised as "inspirational leadership" and ten thousand other opaque explanations. We read of eminent tacticians who "intuitively" knew what the

enemy was planning and hear the "fighting spirit" of D-Day soldiers praised. "Intuition" and "fighting spirit" are no more real than Zeus. Effective commanders anticipate enemy movements by their knowledge of equipment, personnel, doctrine, geography, and so forth. "Fighting spirit" is a phrase that refers to aspects of soldier behavior. "Fighting spirit" is as ethereal as a lead weight.

"Inspirational leadership," "intuition," and "fighting spirit" explain nothing. Opaque attributions direct us from the actual causes of behavior. Training and education are severely afflicted with opaque explanations. Instructors often falsely contend that they are teaching opaque phenomena. Art teachers claim that their courses develop creativity, when what they offer are painting, sculpture, or pottery techniques. Art instructors may mean by creativity that their goal is for their students to make a landscape or some other product, but usually creativity refers to some poorly defined internal thing. Any connection between learning to mix oils and this internal hypothetical entity is never clarified for a very good reason. Creativity, as an internal entity, does not exist.

Opaque explanations are often employed to hide failures. For instance, military and civilian organizations have difficulty training leaders. Our society has much better success training radio operators, systems analysts, surgeons, and behavioral scientists than leaders. If you ask why leadership training is not more effective, you are likely to be told that leadership is more an art than a science. Of course, this reply has nothing to do with either art or science. The speaker is just engaging in a verbal shenanigan, a pretty way of saying that we really do not know much about how to train leaders.

There are two courses that the Army could take in the future study of group processes. Group behavior can continue to be regarded as the product of opaque forces. Managing groups will remain an art for people who take this perspective. These "artists" will find "experts" to create new fashions, endless variations of the same theme. This repetitious cycle will be maintained by the illusion that the next variant may actually improve our understanding of teamwork. Invariably, the new theme is found wanting and needs to be replaced to keep the illusion of progress going.

Persons have professed to study "inspirational leadership," "fighting spirit," and other opaque phenomena as long as there have been armies. Is there likely to be anything gained from further pursuit of these refugees from our animistic past? A quick glance at the last 2,000 years

of military history reveals just how infertile opaque explanations of behavior are. Consider these two questions:

1) Is a Paladin a more effective weapon than a catapult?
2) Are American officers more effective in interacting with their subordinates than were Roman officers?

The Paladin is so far superior to a catapult that the first question is absurd. On the other hand, hard thinking and persuasive talk would be required to demonstrate that American officers are better managers of leader-subordinate interactions than were Roman officers.

The second course open to the Army is to adopt a scientific perspective and regard group processes as ultimately predictable and controllable. Few giant leaps and no miracle solutions will result from a scientific analysis of group processes. Instead, the reward will be a gradual accumulation of knowledge built on a strong empirical foundation. By 2024, it will be obvious that the officer of that time is superior to the officer of 1994 in managing leader-subordinate interactions. Furthermore, investigators could readily identify what has been learned about group processes in the last 30 years.

Army behavioral scientists must take the path of other sciences and discard opaque explanations. Putting Zeus to rest will be difficult. Our very language is replete with opaque constructs and all members of our society have developed maladaptive habits regarding their usage. Opaque explanations are central parts of our culture. Everyone of us has been emotionally conditioned to hold some opaque explanations dear. Abandoning opaque attributions of behavior will compel new ways of defining what it is to be human. The final separation of opaque explanations from science will be difficult.

Still, there is a critical unmet need. The weapons systems of the future will require soldiers to coordinate, communicate, and distribute resources in more efficient ways. The Army's lack of knowledge of group processes is potentially a point of serious vulnerability. Collective skills are one of the most important components of any weapons system. It is unrealistic to believe that the full potential of the physical technologies can be realized when so little is known about group processes. The authors have no doubt that the Army will gradually move from opaque explanations and more vigorously pursue the scientific study of group processes. To persist in an unproductive past would be unworthy of the world's greatest fighting force.

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